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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

MEASURING INFORMATION GLUT: APPLYING SYSTEMS THINKING TO THE PROBLEM OF E-MAIL OVERLOAD

by

Bryan M. Kemmitz

September 2012

Thesis Advisor:	Rick Hayes-Roth
Second Reader:	Brian Steckler

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13. ABSTRACT (maximum 200 words)

As a result of the unregulated rise of superfluous interoffice e-mail, employees currently must wade through inboxes glutted with needless information to find the tidbits of valuable data actually needed to perform their jobs. This problem, also known as e-mail overload, creates unnecessary stress, reduces workplace productivity and fundamentally threatens the information superiority of both private and government enterprises. Organizations that try to combat e-mail overload by employing e-mail policies, filters and personal e-mail management techniques often find that these initiatives miss the mark or do very little to reduce the dissemination of superfluous e-mail. This thesis aims to utilize systems thinking to provide a more complete evaluation of the pitfalls associated with the abovementioned performance improvement initiatives, and also to demonstrate the central (but often overlooked) role that balancing feedback and metrics play in systems that have underlying goal-oriented behaviors. This thesis finally proposes an Information Glut Ratio (IGR) that can potentially provide an organization with a basic, tailorable process for measuring, stabilizing and regulating the amount of superfluous information that gluts e-mail inboxes.

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MEASURING INFORMATION GLUT: APPLYING SYSTEMS THINKING TO THE PROBLEM OF E-MAIL OVERLOAD

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT

from the

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ABSTRACT

As a result of the unregulated rise of superfluous interoffice e-mail, employees currently must wade through inboxes glutted with needless information to find the tidbits of valuable data actually needed to perform their jobs. This problem, also known as e-mail overload, creates unnecessary stress, reduces workplace productivity and fundamentally threatens the information superiority of both private and government enterprises. Organizations that try to combat e-mail overload by employing e-mail policies, filters and personal e-mail management techniques often find that these initiatives miss the mark or do very little to reduce the dissemination of superfluous e-mail. This thesis aims to utilize systems thinking to provide a more complete evaluation of the pitfalls associated with the abovementioned performance improvement initiatives, and also to demonstrate the central (but often overlooked) role that balancing feedback and metrics play in systems that have underlying goal-oriented behaviors. This thesis finally proposes an Information Glut Ratio (IGR) that can potentially provide an organization with a basic, tailorable process for measuring, stabilizing and regulating the amount of superfluous information that gluts e-mail inboxes.

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LIST OF ACRONYMS AND ABBREVIATIONS

ARF	Abuse Reporting Format
BCC	Blind Carbon Copy
CBA	Cost Benefit Analysis
CC	Carbon Copy
CIO	Chief Information Officer
CLD	Causal Loop Diagram
COI	Condition of Interest
CSO	Combat Systems Officer
DNS	Domain Name System
DoD	Department of Defense
DoS	Denial of Service
DSR	Detailed Seller Rating
EOM	End of Message
ESP	E-mail Service Provider
FBL	Complaint Feedback Loop
HA/DR	Humanitarian Assistance/Disaster Relief
HF	High Frequency
HSOC	Homeland Security Operations Center
IGR	Information Glut Ratio
IO	Information Operations
IORG	Information Overload Research Group
IP	Internet Protocol
ISM	Information System Management
IT	Information Technology
NNTR	No Need to Reply
NOSC	Navy Operational Support Center
OEF	Operation Enduring Freedom
OPS	Operations Officer
PC	Performance Coefficient
PDCA	Plan-Do-Check-Act

PSD	Personnel Support Detachment
RFC	Request for Comments
SMTP	Simple Mail Transfer Protocol
SNR	Signal-to-Noise Ratio
TQM	Total Quality Management
UHF	Ultra High Frequency
VIRT	Valued Information at the Right Time

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I. INTRODUCTION

A. OVERVIEW

In February 2010, one of the worst losses of civilian lives to occur in Operation Enduring Freedom (OEF) happened when U.S. helicopters inadvertently fired upon and killed twenty-three unarmed Afghan civilians. Following an investigation, Army and Air Force officials determined that information overload caused the mishap. The Predator drone operators responsible for passing along crucial information to the helicopter pilots had solid reports that the group in question included children; however, the operators did not focus on these valuable bits of information due to the surfeit of data they needed to filter.[1] Their problem did not stem from the unavailability of data or the improper transmission of data, but rather their inability to reduce the overwhelming amount of data bits to only the significant, actionable bits. As Eli Noam, Professor of Finance and Economics at the Columbia Business School, states, "Almost anyone can *add* information. The difficult question is how to *reduce* it."[2] The soldiers and airmen ultimately made a tragic and costly mistake primarily because the valuable data bits needed to make a correct decision remained buried underneath a mound of insignificant data bits. Lt. Gen. David A. Deptula, Air Force Deputy Chief of Staff for Intelligence, Surveillance and Reconnaissance, summarized the military's problem when he stated, "We're going to find ourselves in the not too distant future swimming in sensors and drowning in data."[3]

The overall notion of information overload states that as the volume of data increases and surpasses our capacity to comprehend and act upon it we will experience

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[1] Thom Shanker and Matt Richtel, "In New Military, Data Overload Can Be Deadly," *The New York Times*, January 16, 2011, http://www.nytimes.com/2011/01/17/technology/17brain.html?_r=2&pagewanted=all.

[2] David Shenk, *Data Smog: Surviving the Information Glut* (New York: HarperCollins Publishers, 1997), 29.

[3] Stew Magnuson, "Military 'Swimming in Sensors and Drowning in Data,'" *National Defense Magazine*, January 2010, http://www.nationaldefensemagazine.org/archive/2010/January/Pages/Military'SwimmingInSensorsandDrowninginData'.aspx.

less productivity, increased stress, and a proclivity for making bad decisions. Dr. Torkel Klingberg, Professor of Cognitive Neuroscience at the Karolinska Institute, states that information overload occurs because certain parts of our "frontal and parietal lobes are imposing a limit on how much information [we] can assimilate."[4] In other words, the human brain physically constrains the amount of information that we can accurately process at any given time. By using human reaction-time experiments, Fermin Moscoso del Prado Martín from the Université de Provence in France demonstrated that the brain processes data at roughly 60 bits per second.[5] One can also demonstrate the brain's limitation for processing data by doing a simple back-of-the-envelope calculation. For instance, on average each word has approximately six characters with five bits per character. By taking into account the average reading rate of 250 words per minute with a 70 percent comprehension rate, then a person can roughly process about 87 bits per second.[6] However, even though we recognize the human limitation of information consumption, the exponential rise in digital data has left us more awash in consumable information than any time in our history. For instance, currently over a zettabyte (10^{21} bytes) of digital data resides on the World Wide Web, and this amount grows at a rate of 30 percent per year.[7] In the military, the amount of information gathered by drones and surveillance technology has increased by almost 1,600 percent since 9/11.[8] This means that the incredible exponential growth of information available for processing has greatly surpassed our capacity to process information, a figure of about two orders of magnitude [O (10^2)] bits/second.

Some will argue that more information ultimately leads to more informed decisions; however, situations like those experienced by the previously mentioned UAV

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4 Torkel Klingberg, *The Overflowing Brain: Information Overload and the Limits of Working Memory* (New York: Oxford University Press, Inc., 2009), 163.

5 MIT, "New Measure of Human Brain Processing Speed," *Technology Review*, August 25, 2009, http://www.technologyreview.com/view/415041/new-measure-of-human-brain-processing-speed/.

6 Brenda D. Smith, *Breaking Through: College Reading* (London: Longman, 2005).

7 Ann Blair, "Information Overload, Then and Now," *The Chronicle Review*, November 28, 2010, http://chronicle.com/article/Information-Overload-Then-and/125479/.

8 Shanker and Richtel, "In New Military, Data Overload Can Be Deadly."

operators prove otherwise. The availability of more information does not necessarily equate to individuals or organizations finding and utilizing the right information. On the contrary, more information has actually made it a challenging feat for individuals to find the correct pieces of information needed to perform a task properly. Due to the rising flood of digital data, most people have a difficult time finding and employing even a small fraction of the information available.[9] Instead, we spend our limited cognitive power processing thousands of data bits which add little or no value to the task at hand. One can compare this problem to the challenge of putting together a thousand-piece jigsaw puzzle. If all of the correct puzzle pieces are readily accessible, we can create a valuable end-product given a reasonable amount of time and effort. However, imagine if someone started to dump hundreds-of-thousands of unusable puzzle pieces into the puzzle box. Now, this once achievable task would suddenly turn into an almost insurmountable feat. Enterprises all over the world face this sort of a problem on a daily basis. William J. Martin, author of *The Global Information Society*, believes that the paradox that most organizations now face involves the rising tide of irrelevant information and a "dangerous paucity of that which is needed."[10] Peter Denning, Director of the Cebrowski Institute for information and innovation and superiority at the Naval Postgraduate School in Monterey, CA, states that the "overload of cheap information threatens our ability to function in networks."[11] Information glut adversely affects productivity, degrades network capabilities, and can cause a litany of psychological and sociological effects such as confusion, impaired judgment, and erroneous overconfidence.[12] Researchers have also discovered that information overload causes higher stress levels, reduction in decision-making skills, lower levels of job

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[9] Rick Hayes-Roth, *Hyper-Beings: How Intelligent Organizations Attain Supremacy through Information Superiority* (Bangor: Booklocker.com, 2006), 24.

[10] Angela Edmunds and Anne Morris, "The problem of information overload in business organizations: a review of the literature," *International Journal of Information Management Volume 20*, Issue 1 (2000): 22.

[11] Peter J. Denning,"Infoglut," *Communications of the ACM* 4, no. 7 (July 2006): 15.

[12] Shenk, *Data Smog: Surviving the Information Glut*, 37.

satisfaction, and can affect overall job performance.[13] Smart agents such as content discovery engines, smart filters and adaptive user profiling have shown the potential of somewhat reducing this overload of data; however, receivers are still "glutted by a deluge of low-value data and consumed by attendant low-value tasks."[14] While Internet search-engines, social-networks and blogs have greatly contributed to the growth of superfluous information, e-mail has evolved into one of the largest contributors of information overload within organizations such as the Department of Defense (DoD).

E-mail remains one of the most widely used forms of enterprise communications. The technology's low cost, relative simplicity, speed, reliable delivery and open format allow organizations to rapidly share vast amounts of data. Nevertheless, these same attributes also lead to an increase in the dissemination of useless information. Senders pay a substantially low transaction cost in terms of both money and effort to flood a user's inbox with information.[15] Many organizations have attempted to employ e-mail quality improvement initiatives to control the rising tide of superfluous interoffice e-mails; however, the basic mental models behind these initiatives leave out a very critical function, measured feedback.

B. PURPOSE

This research focuses on exploring the problems associated with e-mail overload, and utilizing systems thinking to better understand why three prominent e-mail quality improvement initiatives fail to reduce superfluous enterprise e-mail properly. In doing so, this research also aims to develop a basic, tailorable process for measuring, stabilizing and regulating the amount of superfluous information currently glutting our inboxes.

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[13] Gail Fann Thomas and Cynthia L King, "Reconceptualizing E-Mail Overload," *Journal of Business and Technical Communication* 20, (2006): 256.

[14] Rick Hayes-Roth, "Valued Information at the Right Time (VIRT): Why less volume is more value in hastily formed networks," *NPS Cebrowski Institute*, 2006, http://faculty.nps.edu/fahayesr/docs/VIRTforHFNs.pdf 1.

[15] Shenk, *Data Smog: Surviving the Information Glut*, 187.

C. RELEVANCE

This study hopefully will make a two-fold contribution to the Information Systems Management (ISM) field and the DoD. First, it seeks to provide a sensitive, concise metric to measure the amount of superfluous information distributed throughout any enterprise e-mail system. Second, the study puts forth a feedback model that organizations can utilize to reduce intelligently the amount of superfluous e-mail that degrades productivity and threatens information superiority.

D. THESIS QUESTIONS

This thesis seeks to address the following research questions:

1. How does an excess of superfluous e-mail impact the ability of an enterprise to produce valuable work?
2. Why do current e-mail quality improvement initiatives fail to control the dissemination of superfluous interoffice e-mail adequately?
3. How can feedback loops and performance metrics help solve the problem of e-mail overload?
4. How can an organization potentially measure information glut?

E. THESIS ORGANIZATION

Chapter I provided a brief introduction and overview of the thesis. The remaining chapters will include the following information:

Chapter II describes the background to the problem, looks at the impact of e-mail overload on information superiority, and examines three different e-mail quality improvement initiatives.

Chapter III describes the theory of systems thinking, and discusses the overall importance of feedback loops and metrics as they relate to goal-seeking systems.

Chapter IV proposes a method for measuring information glut and providing user feedback, and also demonstrates the potential employment of this metric.

Chapter V provides conclusions and recommendations for future research.

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II. BACKGROUND

A. E-MAIL OVERLOAD

Michael Dertouzos, the former Director of the M.I.T. Laboratory for Computer Science, stated that "E-mail is an open duct into your central nervous system. It occupies the brain and reduces productivity."[16] Every e-mail message that a person receives requires a cognitive response, regardless of whether the e-mail contains superfluous or actionable data, and the sheer volume of e-mails received by enterprise workers only compounds this problem. In 1996, Whittaker and Sidner recognized early on the impact of e-mail overload on an individual's ability to manage working information. Their work highlighted how e-mail, once just an asynchronous form of communication, has evolved into a personal archive and the principal method for both receiving and delegating tasks within an enterprise. As a result of this progression, e-mail inboxes have steadily grown both in size and clutter. For instance, in 2009, *The Radicati Group*, a technology market research firm, calculated that an average corporate employee sends and receives close to 167 messages a day, and they predicted that this number will rise to 219 messages a day by 2013 (Table 1).

	2009	2010	2011	2012	2013
Avg. # of Corporate Msgs. Sent/Rec. per Day/User	167	179	192	205	219
Avg. # of Msgs. Sent/Received w/ Attachments	37	40	44	48	53
Avg. # of Msgs. Sent/Received w/o Attachments	130	139	148	157	166
Avg. Size of Msgs. Sent/Received w/ Attachments (KB)	460	470	480	490	500
Avg. Size of Msgs. Sent/Received w/o Attachments (KB)	25	25	26	26	26

Table 1. Corporate E-mail Usage (After Radicati, 2009)

[16] Shenk, *Data Smog: Surviving the Information Glut*, 187.

As a result of this continual rise in e-mail traffic, employees must consume an ever increasing amount of information even though they remain restricted by the same time and cognitive constraints. Employees unable to manage their growing inboxes effectively will overlook or lose important messages, experience reduced responsiveness and potentially create "clear negative outcomes for both individual and corporate productivity."[17] E-mail overload has developed into such a large problem that some of the world's biggest technology companies such as Microsoft, Google, Intel and IBM have even teamed up to form a non-profit research organization called the Information Overload Research Group (IORG).[18] The IORG states that their mission aims to "bring together research, solutions, and people to reduce the impact of information overload."[19] While the IORG has not yet discovered a definitive solution, the fact that e-mail overload has received this type of high-level attention clearly indicates the seriousness of the problem.

1. The Burden of E-mail Overload

In *The Tyranny of Email*, John Freeman states that during the 2008 presidential campaign Barack Obama received only *two* e-mails a day from his foreign policy advisors. His team would gather the thoughts of over three-hundred advisors and summarize the past-twenty four hours of important world events into one e-mail, and in the other e-mail his team would list potential media questions and answers.[20] While a presidential candidate may have the power and clout to regulate his e-mail in this manner, most of us must plow through hundreds of superfluous e-mails in search of golden nuggets of information. Simply imagine the amount of quality work that people could accomplish if their mailboxes included only the valuable bits of information needed to

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[17] Steve Whittaker and Candace Sidner, "Email overload: exploring personal information management of email," Proceedings of the ACM Conference on Human Factors in Computing Systems (New York: ACM, 1996): 277.

[18] Matt Richtel, "Lost in E-Mail, Tech Firms Face Self-Made Beast," *The New York Times*, June 14, 2008.

[19] IORG - Information Overload Research Group, n.d, http://iorgforum.org/about-iorg/, (accessed June 20, 2012).

[20] John Freeman, *The Tyranny of E-mail: The Four-Thousand Year Journey to Your Inbox* (New York: Scribner, 2009), 111.

efficiently and effectively do their jobs. Furthermore, the large amount of superfluous e-mails being received on a daily basis has also led to increased workplace interruptions, and to what Mihaly Csikszentmihalyi, Professor of Psychology at Claremont Graduate University, calls an interrupted state of *flow*. Flow is essentially the condition experienced when one narrows their focus and immerses themselves in both complex thought and work.[21] By being in a state of flow, an individual can reach a kind of productive harmony that supports the creative problem solving and an overall sense of mindfulness needed for constructive work. Yet, instead of a state of flow, most corporate employees remain in a state of constant reaction due to the invasive power of e-mail. Today, any employee with an e-mail address can interrupt the flow of work by simply sending, forwarding or duplicating messages to anyone within their corporate address book.[22] In *Flow: The Psychology of Optimal Experience*, Csikszentmihalyi states that flow "begins with achieving control of our consciousness."[23] However, e-mail interruptions defy the act of actually getting control of our consciousness because they consume so much of our productive time and energy. Herbert A. Simon, notable cognitive psychologist, states that "what information consumes is rather obvious: it consumes the attention of its recipients."[24] This suggests that the more e-mails we receive the more our finite attention requires apportioning.

In a study of employee e-mail usage at the Danwood Group, a print management and consultancy firm, researchers from Loughborough University discovered that employees viewed 70% of their e-mails within six seconds, and that the time it took to recover from each e-mail interruption and return to work averaged 64 seconds.[25] This suggests that if an employee received 60 e-mails a day, he/she would spend roughly 64 minutes of each work day just recovering from e-mail interruptions. In a separate

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21 Ibid., 142.

22 Ibid., 98.

23 Mihály Csíkszentmihályi, *Flow: The Psychology of Optimal Experience* (New York: Harper Collins Publishers, 1991), 2.

24 Freeman, *The Tyranny of E-mail*, 139.

25 Thomas Jackson, Ray Dawson, and Darren Wilson, "The Cost of Email Interruption," *Journal of Systems and Information Technology* 5, no. 1 (2001): 86.

study, researchers discovered that e-mail users were interrupted by 4.28 e-mail alerts per hour, and that the time it took to resume suspended work after responding to an e-mail averaged *16 minutes and 33 seconds*.[26] Based on their findings, the researchers speculated that these extraordinarily high resumption times occurred mostly because the e-mail users had to reacquire memories about the previous tasks that they were working on, and subsequently refocus their "cognitive resources that may have been usurped during the diversion phase."[27] These interrupted states of flow can clearly reduce productivity, and as a result they ultimately carry a heavy price tag for both the user and the enterprise. A study done by Basex Research found that businesses lose an estimated $650 billion annually in productivity due to unnecessary e-mail interruptions.[28] While eliminating all e-mail interruptions will certainly remain a difficult feat for the foreseeable future, limiting e-mail interruptions to only significant, actionable messages will help combat the problems associated with e-mail overload.

2. Information Quality

In most enterprises, members can probably point out the most habitual offenders who carelessly glut their colleagues' inboxes with superfluous information. Individuals who abuse features such as carbon-copy, forward long email threads, misuse attachments and fundamentally fail to carefully scrutinize the value of the information that they send and to whom they send it to. If one considers that our access to actionable, valuable information drives our ability to make correct decisions, then the constant saturation of our e-mail inboxes with poor quality information will lead to wasted time, incorrect decisions and a reduction in value-added work. Ultimately, quality information stimulates quality thinking in an organization, and quality thinking leads to organizational success. In *Hyper-Beings: How Intelligent Organizations Attain Supremacy through Information Superiority*, Dr. Rick Hayes-Roth, professor of Information Sciences at the

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[26] Shamsi T Iqbal and Eric Horvitz. "Disruption and Recovery of Computing Tasks: Field Study, Analysis, and Directions," *Proceedings of the SIGCHI conference on Human factors in computing systems (CHI '07)* (New York: ACM, 2007), 683.

[27] Ibid.

[28] Ross Mayfield, "E-Mail Hell," *Forbes*, October 15, 2008, http://www.forbes.com/2008/10/15/cio-email-manage-tech-cio-cx_rm_1015email.html.

Naval Postgraduate School, states that "Where in the past advantages might have accrued purely to size, strength, wealth or physical skills, the quality of an organization's thinking most determines success in the future."[29]

This means that the effectiveness of e-mail as a communication medium depends on the amount of significant, actionable data it can provide information consumers in relation to the amount of superfluous data bogging them down. E-mail does deliver actionable data; however, superfluous data often times muddles and buries it. As a result, recipients spend "time scanning, browsing, filtering, and prioritizing incoming queues that are overflowing with relevant, but mostly insignificant information."[30] In an effort to cope with this glut of information, users will not read carefully, disregard, hand-off or self-filter incoming messages.[31] This problem primarily occurs because the e-mails sent fundamentally lack the proper elements of information quality. In *Network Centric Warfare: Developing and Leveraging Information Superiority*, the authors explain that information quality reaches its upper limits when the dimensions of relevance, accuracy and timeliness approach 100 percent.[32]

Relevance: Individuals receive e-mails with irrelevant and useless content. For instance, a 1999 Intel e-mail usage survey found that knowledge workers perceive roughly 30% of their received e-mails as unnecessary.[33] A separate study conducted by the Gartner Group also found that 30% of the e-mails received by workers today consist

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[29] Hayes-Roth, *Hyper-Beings*, 29.

[30] Rick Hayes-Roth, "Two Theories of Process Design for Information Superiority: Smart Pull vs. Smart Push," (paper presented at the 2006 Command and Control Research and Technology Symposium, San Diego, California, 2006), 12.

[31] Denning, "Infoglut," 16.

[32] David S Alberts, John J Garstka, and Frederick P. Stein, *Network Centric Warfare: Developing and Leveraging Information Superiority* (Washington, DC: DoD C4ISR Cooperative Research Program, 2000), 32.

[33] Nathan Zeldes, David Sward, and Sigal Louchheim, "Infomania: Why we can't afford to ignore it any longer," *First Monday: Peer Reviewed Journal on the Internet*, August 6, 2007, http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/1973/1848.

of "occupational spam," characterized by excessive CC, BCC and reply-to-all use.[34] This means that people receive between 20 to 45 unnecessary e-mails every day. Tim Barker, Vice President of EMEA strategy for *Salesforce.com*, said that "The habit of 'blasting' out emails to a large group of people to ensure that there is no chance of leaving anyone out of a particular message has created a situation where email is now becoming counter-productive."[35]

Accuracy: Individuals receive e-mails that contain erroneous information. Due to the relative ease and cost it takes to mass-produce and send e-mails, many people do not take the time to properly scrutinize the accuracy of the information that they disseminate. In December 2011, the *New York Times* mistakenly sent eight-million people an e-mail offering a 50 percent reduced rate on home delivery of their newspaper; however, only about 300 people who had opted to stop receiving the newspaper's service should have ever received the e-mail.[36] This resulted in a public embarrassment for the company, who admitted the human-error, but it also resulted in millions of people receiving inaccurate information. In February 2012, a similar incident occurred when the Office of Personnel Management sent 300 Presidential Management Fellows applicants an e-mail congratulating them as finalists; however, the program office had actually rejected those applicants.[37]

Timeliness: Individuals receive e-mails that have untimely information. Even if an e-mail contains relevant data, if the e-mail does not get delivered in a timely manner the information becomes practically useless to the consumer. Furthermore, while e-mail as a form of communication transmits information incredibly fast, if an e-mail has out-of-date information then the speed of the technology offers no tangible benefits. Following

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[34] Mayfield, "E-Mail Hell."

[35] Anh Nguyen, "Email is 'Counter-Productive' Says Salesforce.Com'," *CIO*, September 8, 2010, http://www.cio.com/article/610593/Email_is_Counter_Productive_Says_Salesforce.Com.

[36] Paul Thomasch and Jim Finkle,"New York Times sends email to millions by mistake," *Reuters*, December 29, 2011, http://www.reuters.com/article/2011/12/29/us-newyorktimes-subscribers-idUSTRE7BS0IH20111229.

[37] Stephen Losey, "OPM mistakenly tells 300 they are Presidential Management Fellows Finalists," *Federal Times*, February 10, 2012, http://www.federaltimes.com/article/20120210/PERSONNEL02/202100303/.

a catastrophic incident, Humanitarian Assistance/Disaster Relief (HA/DR) responders and the affected population require a steady flow of timely information in the critical areas of security, logistics, medical, transportation and communications in order to save lives.[38] However, when provided with old information, valuable time and resources get wasted on processing unneeded data. For instance, during the response for Hurricane Katrina, a White House Homeland Security official stated in an e-mail that "sending us very stale sit-rep info that has already been updated (earlier) by the HSOC is not as helpful. Is there a way to coordinate the info flow so we don't waste time receiving such old data and you folks don't waste time sending us stuff?"[39] With e-mail, even timely information can turn into untimely information when not read quickly or when subsequently sent messages supersede it. Therefore, a negative cycle forms between glut and low-value information, as potentially timely data becomes stale when people are too busy to consume it fresh.

Considering these three criteria, one can classify a quality e-mail as a message that contains significant, accurate information that gets delivered to the appropriate person in a timely fashion. On the contrary, e-mails that are insignificant, sent to incorrect recipients, and not sent or processed in a timely manner can be considered superfluous.

3. The Effects of Superfluous E-mails on Information Superiority

In an *Armed Forces Journal* article, Air Force Colonel Peter R. Marksteiner directly addresses the issue of superfluous information with regard to the growing problem of e-mail overload within the DoD. He maintains that valuable information and tasks constantly get buried in an "inescapable rising tide of inconsequential flotsam."[40] Undisciplined and careless data providers glut e-mail inboxes by sending out non-mission

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[38]Manuel Bessler, *Civil-Military Guidelines & Reference for Complex Emergencies* (New York: United Nations Office for the Coordination of Humanitarian Affairs, 2008), 34.

[39] Christopher Cooper and Robert Block, *Disaster: Hurricane Katrina and the Failure of Homeland Security* (New York: Times Books, 2006), 197.

[40] Peter R. Marksteiner, "The threat from within: E-mail overload degrades military decision-making," *Armed Forces Journal*, September 1, 2008, http://www.armedforcesjournal.com/2008/09/3640424/.

related information, unintentionally concealing valuable data within never-ending e-mail chains and overusing features like "reply-to-all" and "carbon-copy."

While this problem clearly frustrates the vast majority of corporate enterprises, Marksteiner further acknowledges that e-mail overload has turned into an Information Operations (IO) threat to the military. He states that poorly drafted messages and superfluous information essentially hobbles "the cognitive dimension of the information environment."[41] Department of Defense (DoD) Joint Publication 3-13 states that to achieve information superiority, one must have the "ability to collect, process and disseminate and uninterrupted flow of information while exploiting and/or denying an adversary's ability to do the same."[42] Considering this, the military should think of superfluous e-mail as essentially an unintentional insider threat imposing a self-inflicted denial of service (DoS).[43] The rising tide of insignificant information degrades the ability of our military leaders to properly obtain valuable information and react in a timely manner. In *Command in War*, Martin Van Creveld states that a leader's ability to distinguish between relevant and irrelevant information remains as one of the most important aspects of command.[44] However, due to the volume of irrelevant information getting distributed, leaders now must spend an excessive amount of time simply sifting through their e-mails just to find any sort of relevant information. The military fully acknowledges that quality information represents the cornerstone for information superiority. Joint Publication 3-13 even puts forth an information quality criteria designed to help military leaders improve their information quality (Figure 1).

However, while military commands try to apply these guidelines in the battlefield, they habitually ignore these guidelines when it comes to enterprise e-mail. Hayes-Roth states that "information-superior organizations reach better decisions and implement them more effectively than mediocre organizations," ultimately creating an "unfair

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[41] Ibid.

[42] Joint Chiefs of Staff, *Joint Publication 3-13: Information Operations*, Washington, DC, February 13, 2006, 10.

[43] Marksteiner, "The threat from within: E-mail overload degrades military decision-making."

[44] Martin L. Van Creveld, *Command in War* (Cambridge: Harvard University Press, 1985), 262.

advantage."[45] Therefore, if the military wants to become an information-superior organization, it must work harder at significantly reducing the overall amount of superfluous e-mails that disrupt their leaders' cognitive capabilities. If human processing power truly represents our scarcest and most valuable resource, then why should we waste it on processing useless information? As the cartoonist Walt Kelly once stated, "We have met the enemy and he is us."[46]

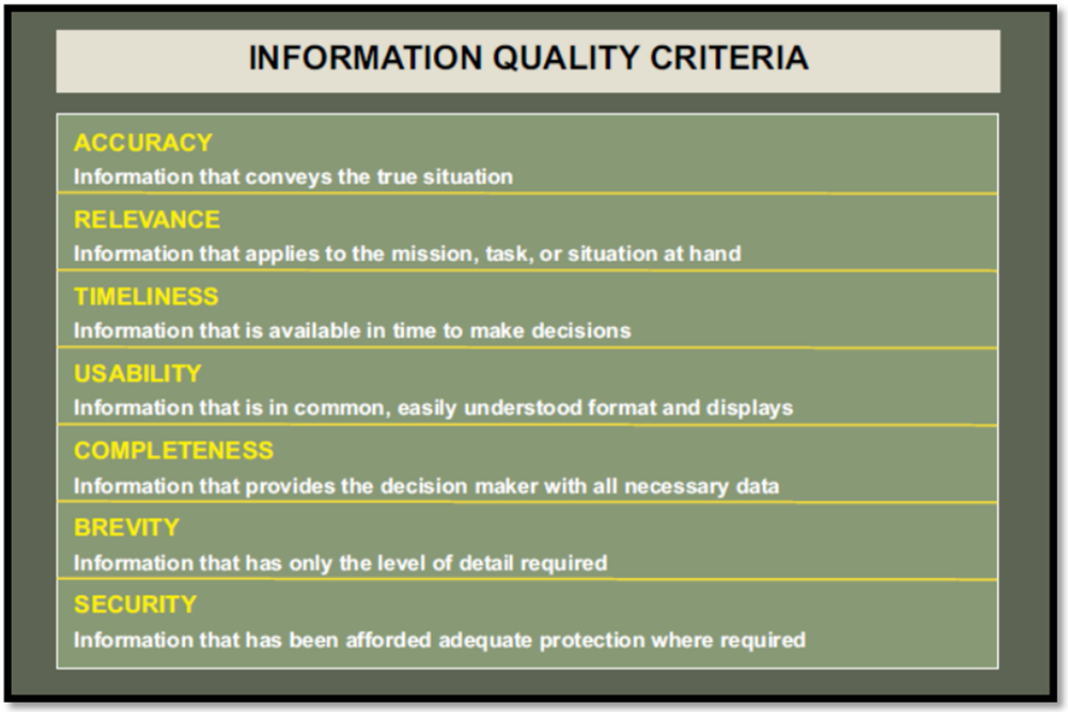
INFORMATION QUALITY CRITERIA
ACCURACY
Information that conveys the true situation
RELEVANCE
Information that applies to the mission, task, or situation at hand
TIMELINESS
Information that is available in time to make decisions
USABILITY
Information that is in common, easily understood format and displays
COMPLETENESS
Information that provides the decision maker with all necessary data
BREVITY
Information that has only the level of detail required
SECURITY
Information that has been afforded adequate protection where required

Figure 1. Information Quality Criteria (From Joint Chiefs of Staff, 2006)

B. E-MAIL QUALITY IMPROVEMENT INITIATIVES

Many organizations now realize the problems associated with e-mail overload, and have subsequently started to employ quality improvement initiatives in order to increase their information superiority and help reduce the burden that superfluous e-mails

[45] Hayes-Roth, *Hyper-Beings*, 2.

[46] Walt Kelly, *Pogo: We have met the Enemy and He is Us* (Simon and Schuster, 1972).

place on their workforce. Some of the most well-known efforts involve the employment of e-mail charters and policies, the encouragement of personal e-mail management and the use of e-mail filters.

1. E-mail Charters and Policies

To help alleviate the problem of e-mail glut within the DoD, Colonel Marksteiner advocates developing an institutional e-mail policy that would encourage users to become better data providers. This policy would include sensible guidelines such as clearly indicating the e-mails that require action as "tasks," using recognizable identifiers and labels to mark "water-cooler discussions," and using reply-all features very sparingly.[47] This suggests that if an enterprise could follow an e-mail policy similar to the one Marksteiner proposes, then the quality of e-mail would increase, superfluous information would decrease, and in the end more value-added work would get accomplished. The website *EmailCharter.org* also advocates a similar response to e-mail glut. Chris Anderson, curator of the *Technology, Entertainment, and Design (TED*) conference, created the website as a way to encourage a community response to the problem of e-mail overload.[48] On the charter, he puts forth ten rules to reverse the e-mail spiral. [49] They can be summarized as follows:

- Respect recipients' time: Understand the value of your recipient time, and ensure that your e-mails do not take an excessive amount of time to process.
- Short or slow is not rude: Lower the expectations for timeliness and detail with respect to e-mail responses.
- Celebrate Clarity: Clearly label e-mails with appropriate subject lines, and include status categories such as *Info*, *Action*, and *Low-Priority*. Additionally, users should try to write crisp sentences, preferably no more than five.
- Quash open-ended questions: Do not send e-mails that ask questions which are designed to elicit full, meaningful answers such as "Thoughts?" or "How can I help you?" Instead, users need to write simple, easy-to-answer questions.

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[47] Marksteiner, "The threat from within: E-mail overload degrades military decision-making."

[48] Chris Anderson, "How to stop e-mail overload? Think before you hit send," *The Washington Post*, September 9, 2011, http://www.washingtonpost.com/opinions/how-to-stop-e-mail-overload-think-before-you-hit-send/2011/09/09/gIQATMBorK_story.html.

[49] Christopher Anderson and Jane Wulf, *E-mail Charter*, June 9, 2011, http://emailcharter.org/about.html.

- Slash surplus cc's: Using the carbon-copy feature on e-mail to reach multiple recipients can help to reduce work; however, the more recipients carbon-copied will inherently multiply the response time. Therefore, one should cut down on the amount of carbon-copying.
- Tighten the thread: Often times, e-mail users will forward long threads of past emails to provide context for their messages. Anderson recommends saving the recipient some time by tightening the thread to no more than three e-mails.
- Attack attachments: As the Radicati Group study revealed, the average size of an e-mail's sent with attachments is approximately 480 KB and steadily increasing. These attachments can slow down e-mail performance, effect mailbox limits, and waste time. Considering this, users should try to minimize the size and amount of attachments that they send.
- Give these gifts (EOM NNTR): Anderson states if the message can be expressed in less than six words, the e-mail sender should simply utilize the acronym EOM (End of Message) to save the recipient from having to open the message. Also, if senders do not need a response from their recipients, they should use the acronym NNTR (No Need to Reply).
- Cut countless responses: Recipients should only reply to e-mails when absolutely necessary. Sending one word e-mails like "Thanks" or "Great" merely for the sake of acknowledgment wastes time and causes interruptions.
- Disconnect: Anderson essentially argues that in order to receive less e-mail we need to send less e-mail. Therefore, enterprises should intentionally schedule breaks from the technology, and employees should try to detach as much as possible.

Colonel Marksteiner's e-mail policy and Chris Anderson's e-mail charter can potentially encourage mindful data sharing within an enterprise. However, when these policies go unregulated, individuals will simply view them as ignorable workplace recommendations. For instance, consider a community library with a large sign posted on the front door that says *Please be Quiet.* A new patron will see the sign, and then notice that everyone in the library adheres to the rule. Furthermore, the new patron will also notice a librarian ready to regulate those individuals who get too noisy. As a result, the new patron will subsequently adjust his or her behavior to conform to the group's rule-following behavior. On the other hand, if the patron walked into the library and observed people chatting, laughing and talking on their cell phones without any form of regulation, then the new patron would likely ignore the sign and conform to the group's rule-violating behavior. This analogy demonstrates that goals and rules will never constitute the sole drivers of behavioral change within an organization. Charters and policies provide great guidelines, but the social norms of the organization need to change

to create lasting impressions. Social norms are the standards or rules that govern acceptable behavior within a group.[50] Philosopher David Lewis states that "once a particular way of doing things becomes established as a rule, it continues in force because we prefer to conform to the rule given the expectation that others are going to conform."[51] Therefore, with regard to e-mail, if users realize that other individuals do not conform to the rules, they will also not conform.

Some enterprises view the problems associated with e-mail overload as inherent flaws of the technology. For instance, Thierry Breton, CEO of the information technology company Atos, recently implemented a "zero-email" policy because he believed that e-mails were polluting his company's working environment, and that only ten percent of the 200 messages his employees received per day were actually useful.[52] Today, his company relies on other avenues such as instant messaging and social collaboration tools for intra-office communications. However, this approach compares to a doctor treating a patient's symptom instead of the disease. Superfluous information will continue to pollute the work environment of Atos, but a different medium will disseminate it. In most enterprises, e-mail remains the communication mode of choice because it can effectively and rapidly distribute valuable tasks and information. In contrast to other office communications such as face-to face meetings, telephone, voice-mail, postal-mail and faxes, e-mail stands as the only medium capable of meeting all of the following characteristics: asynchronous, text-based, multiple addressability, and built-in memory.[53] Therefore, the value of the information contained in the e-mail creates the problem, not the technology used to transmit the information. Considering this, e-mail charters and policies can encourage individuals to reduce the amount of insignificant data creating information glut; however, users ultimately need proper regulation in order to promote the required social-normative changes.

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[50] Stanford, "Social Norms," *Stanford Encyclopedia of Philosophy*, March 1, 2011, http://plato.stanford.edu/entries/social-norms/.

[51] H. Peyton Young, *Social Norms*, Discussion Paper, (Oxford: University of Oxford, 2007), 3.

[52] Susanna Kim, "Tech Firm Implements Employee 'Zero Email' Policy," *ABC News*, November 29, 2011, http://news.yahoo.com/tech-firm-implements-employee-zero-email-policy-165311050.html.

[53] Thomas and King, "Reconceptualizing E-Mail Overload," 255.

2. Personal E-mail Management

Personal e-mail management remains one of the most advocated e-mail quality improvement initiatives. The subject has motivated a plethora of scholarly papers and books. Personal e-mail management primarily focuses on encouraging recipients to practice more disciplined and efficient methods for processing and organizing their e-mails. For instance, Whitaker and Sidner's solution to e-mail overload urges users to collect, organize and file their e-mails more effectively.[54] Daily, habitual e-mail management would assist individuals with distinguishing important e-mails and avoiding useless e-mails. David Allen, a well-known productivity consultant, proposes a similar solution with his *Getting Things Done (GTD)* methodology that encourages individuals to improve their personal workflow management by practicing more efficient task organization and time management skills. Mark Hurst, author of *Bit Literacy: Productivity in the age of Information and E-mail Overload* has another novel solution to e-mail overload: "don't become overloaded."[55] In other words, e-mail recipients must take personal responsibility for maintaining an empty inbox. He recommends simply clearing your inbox of e-mails on a daily basis. We should organize and file e-mails, but most importantly we should just get rid of them so that they do not turn into "stress-inducing distractions."[56] However, these personal e-mail management solutions erroneously place the onus of reducing e-mail overload only on the recipient, when the data provider should also share this responsibility. These solutions bring to mind the proverbial hamster-wheel; once started, it becomes increasingly difficult to stop the sorting, prioritizing and deleting of e-mails.

These hamster-wheels also frequently lead to misguided perceptions of control. Dr. Ellen Langer, a professor of psychology at Harvard, believes that people often create an illusion of control, and habitually have a tendency to exaggerate their perceptions of

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54 Whittaker and Sidner, "Email overload: exploring personal information management of email," 277.

55 Mark Hurst, *Bit Literacy: Productivity in the Age of Information and E-mail Overload* (New York: Good Experience Press, 2007), 21.

56 Hurst, *Bit Literacy*, 25.

control.[57] In this case, people believe and act as if they have control of their inboxes, but they truly have no control over the amount of superfluous e-mail actually coming in. The problem with this "illusion of control" arises when people begin to set improbable goals like "don't become overloaded," which will only increase the likelihood of failure.[58] Once a person takes a break from the persistent sorting, prioritizing and deleting, they will quickly feel as if they have lost complete control.

Furthermore, personal e-mail management consumes a great amount of time. For instance, if each member of a five-thousand person organization spent just two-hours per week conducting inbox housekeeping, it would eventually sum to over ten thousand-hours of lost work per week.[59] While personal e-mail management can potentially improve productivity for those individuals who have the time and capacity to master the techniques, these solutions ultimately fail to address one of the root causes for e-mail overload in the first place: data providers sending an excess of superfluous information.

3. E-mail Filters

E-mail filters perform exceptionally well at minimizing spam, also known as unsolicited junk-mail. Most e-mail filters operate by examining the content of e-mails for specific blacklisted words. If an e-mail client finds a blacklisted word within an e-mail, then the client will either quarantine the message in a junk-mail folder or delete it. Another widely used anti-spam filtering technique involves the employment of Domain Name System (DNS) blacklists. Internet Protocol (IP) addresses, associated with sending junk-mail, get published in databases known as DNS blacklists. The Internet DNS makes these databases available, and e-mail clients simply query the databases and deny any e-mails coming from the bad addresses.[60] Spam can unquestionably grow into a major

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[57] Tarek K.A. Hamid, *Thinking in Circles about Obesity* (New York: Springer, 2009), 174.

[58] Hamid, *Thinking in Circles about Obesity*, 174.

[59] Miriam Schulman, "E-mania: Ethical Approaches to E-mail Overload," *Santa Clara University: Markkula Center for Applied Ethics*, June 24, 2005, http://www.scu.edu/ethics/publications/submitted/emailoverload.html.

[60] Jaeyeon Jung and Emil Sit, "An empirical study of spam traffic and the use of DNS black lists," *4th ACM SIGCOMM conference on Internet measurement* (IMC '04) (New York: ACM, 2004), 370.

threat to the effectiveness of e-mail if not handled correctly. In 2009, spam accounted for approximately eighty-one percent of overall e-mail volume (Table 2).[61] However, due to the overall success of filters, only a small fraction of spam actually ends up disrupting e-mail users. Spam does not cause information overload, as Miriam Schulman from the Markkula Center for Applied Ethics at Santa Clara University states, "The real culprit in the corporation is e-mail from within the organization. Workers have to figure out how to sort the crucial meeting dates from the notices of retirement parties for employees in obscure departments; the significant memos from the 'cover your behind' cc's on projects in which they have no direct involvement."[62] Current state-of-art e-mail filters do not flush out superfluous e-mails sent from within the enterprise. However, this raises the question; why not create a filter that reduces the amount of low-value e-mails created from within an enterprise?

	2009	**2010**	**2011**	**2012**	**2013**
Worldwide Messages/Day (B)	247	294	349	419	507
Worldwide Spam Traffic/Day (B)	199	238	286	347	424
Total Spam %	*81%*	*81%*	*82%*	*83%*	*84%*

Table 2. Worldwide Spam Traffic (After Radicati, 2009)

Hayes-Roth proposes that one way to prevent receivers from getting glutted by a deluge of low-value data is to use a high-value filtering service known as *Valued Information at the Right Time* (VIRT).[63] The basic VIRT architecture relies upon data-consumers creating conditions-of-interests (COIs). VIRT defines COIs as significant events that typically warrant immediate action by the applicable user.[64] A dependency

[61] Radicati and Khmartseva, *E-mail Statistics Report, 2009–2013*.

[62] Schulman, "E-mania: Ethical Approaches to E-mail Overload."

[63] Hayes-Roth, "Valued Information at the Right Time (VIRT)", 1.

[64] Hayes-Roth, "Valued Information at the Right Time (VIRT)", 4.

monitor would scan information-registries for these significant events and then deliver "a bit stream to each consumer comprising just the bits of most value to that consumer in addressing current concerns or interests" (Figure 2).[65] If implemented correctly, these tailored mechanisms could greatly reduce superfluous information from overloading decision makers. The system would be configured to send only the data that satisfies a given consumer's COIs.[66] As a result, Hayes-Roth estimates that a VIRT model could reduce bit flows by five or more orders of magnitude.[67] Therefore, in theory, VIRT could drastically reduce information overload in the tactical environment, such as our prior example of the UAV operating in OEF. The data consumer would only receive the actionable bits of information most significant for the overall success of the mission.

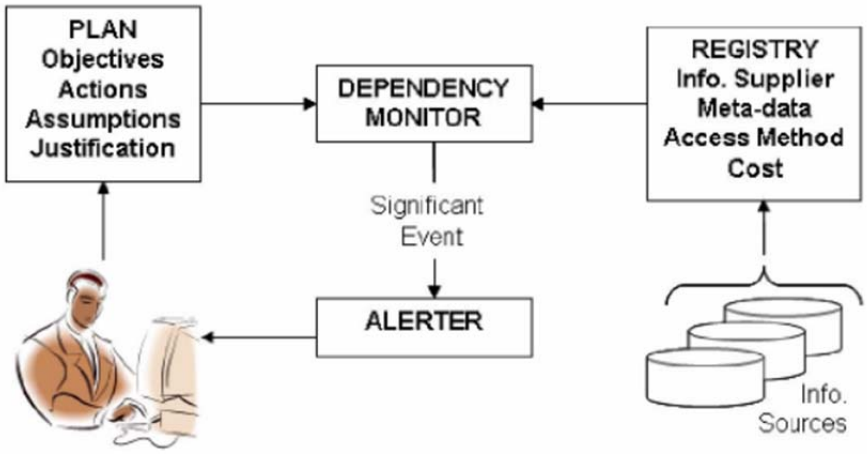

Figure 2. A simplified architecture for VIRT (From Hayes-Roth, 2006)

With regard to e-mail, a VIRT system would work like an inverse spam filter. A VIRT system would scan e-mails for whitelisted keywords or phrases and then only push e-mails that matched a consumer's syntactic rules or COIs. All other messages would be blocked or withheld. However, with regard to standard office communications, this would likely raise the number of incorrect rejections—valuable emails blocked by the

65 Denning, "Infoglut," 17.

66 Ibid.

67 Rick Hayes-Roth, "Model-based Communication Networks and VIRT: Orders of Magnitude Better for Information Superiority," (paper presented at MILCOM 2006, Washington, DC, 2006), 5.

dependency monitor. David Shenk would refer to this problem as "extreme nichification."[68] A data consumer's plan or COI could become so tailored that the consumer would eventually begin to miss out on wide-ranging, more generic pieces of information that may potentially hold value to the consumer. Additionally, developing and defining syntactic rules to distinguish between valuable e-mail messages and insignificant messages could also prove difficult to implement for every individual within a large enterprise.[69] Blacklisting too many words and phrases or whitelisting too little COIs will also cause senders to constantly question whether their e-mails are properly received, and cause recipients to constantly question whether they are receiving all of their messages.

Using tools like DNS Blacklists would also cause problems. While this solution works when it comes to handling bulk e-mail providers, in an office environment, completely blocking a coworker's IP address would eventually lead to serious issues. Even if ninety-five percent of the coworker's e-mails were superfluous, the potential of missing just five percent of his significant e-mails could prove costly. In the end, using filters to block superfluous office e-mails would make the communication technology too onerous and unreliable to effectively use.

C. SUMMARY

Ultimately, the spirit of filtering tools, like VIRT, can help prevent superfluous information from glutting our e-mail inboxes. Hayes-Roth states that "the essence of VIRT is knowing which consumers really care about what news."[70] Likewise, the intent of improving e-mail quality is fundamentally about meeting recipients' needs. E-mail providers must begin to learn which individuals value certain information, then work hard at improving the quality of information they disseminate. E-mail quality

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[68] Shenk, *Data Smog: Surviving the Information Glut*, 128.

[69] Robert J. Hall, "How to avoid unwanted email," *Communications of the ACM* 41, no. 3 (March 1998): 94.

[70] Rick Hayes-Roth, Model-based Communication Networks and VIRT: Filtering Information by Value to Improve Collaborative Decision-Making," (paper presented at the 10th International Command and Control Research and Technology Symposium: The Future of C2, McLean, Virginia, 2005).

improvement initiatives such as e-mail charters, personal e-mail management, and basic e-mail filters have no credible process built into their models that support the amount of consumer feedback and continuous improvement needed to support this behavior. Considering this, in the following chapter we will look at the problem of e-mail overload through the lens of *systems thinking*, and demonstrate that e-mail quality improvement efforts will consistently fail without properly addressing this missing feedback process.

III. SYSTEMS THINKING ABOUT E-MAIL GLUT

A. WHY DO E-MAIL QUALITY IMPROVEMENT INITIATIVES FAIL?

As Chapter II describes, a major challenge that many enterprises face today involves trying to control e-mail overload. In particular, enterprises try to improve the quality of e-mail in an effort to cut down on the large quantities of superfluous interoffice e-mails that essentially glut their users' inboxes. However, most of the quality improvement efforts that organizations employ today completely miss the mark, lack sustainability, or simply operate without proper regulation. Ultimately, the poor quality of the underlying mental models of these performance-improvement initiatives helped to lay the foundation for these failures.[71]

In *The Fifth Discipline: The Art & Practice of the Learning Organization*, Peter Senge states, "mental models are deeply ingrained assumptions, generalizations, or even pictures…that influence how we understand the world and how we take action."[72] For example, a common illustration of a mental model involves a person driving a car. For most drivers, their mental models comprise simple generalizations. They assume that their car accelerates because they put their foot on the gas pedal. Likewise, their car stops because they press down on the brake. Fortunately, for the purposes of driving, this mental model typically suffices. However, if the car starts to malfunction, a person would need a more in-depth mental model of how the car actually operates in order to repair the vehicle. Therefore, the quality of a mental model ultimately depends upon the content the individual chooses to put in and leave out of the model.[73] With respect to e-mail quality improvement initiatives, the mental models used to fix the problem of e-mail overload leave out one of the most significant yet simple concepts—feedback. Feedback enhances the quality of most mental models primarily, because human behavior (as with

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[71] Barry Richmond, *An Introduction to Systems Thinking* (Hanover: High Performance Systems, Inc., 2001), 1.

[72] Peter M. Senge, The *Fifth Discipline: The Art & Practice of the Learning Organization* (New York: Doubleday, 1990), 8.

[73] Richmond, *An Introduction to Systems Thinking*, 8.

all animals) gets shaped by reinforcement. Simply put, when something gets rewarded individuals will tend to do it again. For instance, Edward Thorndike's *Law of Effect* states "responses that produce a satisfying effect in a particular situation become more likely to occur again in that situation, and responses that produce a discomforting effect become less likely to occur again in that situation."[74] Therefore, when an organization wants to change behavior, it needs to consider incentives and rewards. More generally, systems theorists refer to this idea of getting information and using it to shape and adapt behavior as *feedback*.

Jay Wright Forrester stated, "Everything we do as individuals, as an industry, or as a society is done in the context of an information-feedback system."[75] Yet, when it comes to battling e-mail glut, our solutions fail to account for feedback, because our mental models do not encompass the whole picture. Therefore, to understand the underlying importance that feedback plays within quality mental models, we must first take a closer look at the practice of systems thinking.

B. SYSTEMS THINKING

Everything that we will ever encounter in the world belongs to some type of system. The definition of a system is "[A] construct or collection of different elements that together produce results not obtainable by the elements alone."[76] This suggests that forest ecosystems, schools, businesses, military organizations, human circulatory systems, vehicle traffic and even enterprise e-mail all warrant the categorization of a system. Furthermore, each of these systems comprises elements, interconnections and functions or goals.[77] How these elements work, remain connected to one another, and attempt to reach their goals determine the overall success or failure of the system. Considering this, the practice of systems thinking largely consists of trying to

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[74] Peter O. Gray, *Psychology: 5th Edition* (New York: Worth Publishers, 2006), 106.

[75] Donella H. Meadows, *Thinking in Systems* (White River Junction: Chelsea Green Publishing, 2008), 25.

[76] Eberhardt Rechtin, *Systems Architecting of Organizations: Why Eagles Can't Swim* (Boca Raton: CRC Press LLC, 2000), 4.

[77] Meadows, *Thinking in Systems*, 11.

conceptualize our mental models differently. It involves looking beyond linear cause and effect chains, seeing the actual processes of change, and understanding the power of feedback.[78]

1. Causality is Circular

When attempting to solve problems, many people primarily look for one-way causal links—A causes B or C causes D. This methodology normally works when the problem remains relatively simple. For instance, if your car has a flat tire, you can effectively link the cause of the flat to a puncture or a malfunctioning valve stem. However, people often incorrectly address issues when they try to apply unidirectional causation to more complex problems. With problems such as drug abuse, education, crime and practically most human behavior, causation tends to work circularly and not linearly.[79] For instance, perhaps poverty could cause lower test scores; however, the possibility also exists that lower test scores could cause poverty. Peter Senge states that all "reality is made up of circles, but we see in straight lines."[80] This straight-line thinking often leads decision makers and problem solvers into troubled waters, because they do not pay close enough attention to how all the interconnected components of a system work together. The mental models that we develop for solving problems usually get formed by an ingrained assumption that factors operate independently.[81] We assume that in order to solve a problem, we only need to adjust certain independent factors and then sit back and watch for the expected outcome to occur (Figure 3). As a result of this flawed thinking, we often conceive misguided solutions to the behavioral problems that our organizations face.

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[78] Senge, *The Fifth Discipline*, 73.

[79] Hamid, *Thinking in Circles about Obesity*, 33.

[80] Senge, *The Fifth Discipline*, 73.

[81] Richmond, *An Introduction to Systems Thinking*, 9.

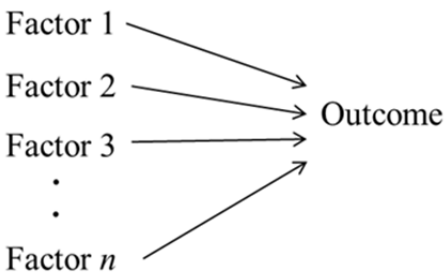

Figure 3. "Critical Success Factor" model (After Richmond, 2001)

For example, Dr. Tarek Abdel-Hamid, Professor of Systems Dynamics at the Naval Postgraduate School, examined how the struggle for weight loss often gets addressed incorrectly because individuals assume that they only need to adjust their food intake. However, when individuals use this mental model they typically discover that dieting alone usually fails, or it produces substantially lower weight loss than anticipated. When individuals restrict their caloric intake, they actually "trigger involuntary energy conservation measures" that deplete their energy balance and consequently increase their food intake (Figure 4).[82] Therefore, if someone has a substantial weight problem, that person's energy conservation measures would work substantially harder than a thinner person's. This means that weight affects appetite, and appetite affects weight. Through homoeostasis, the body regulates the shortage in caloric intake by sending information (feedback) to the brain to start eating more food in order to reduce the gap between the dieter's reduced caloric balance and his/her body's normal caloric balance. When information triggers an action to reduce a gap between two levels, systems theorists refer to this type of information as negative feedback.[83] A system uses negative feedback to regulate the system until it eventually reaches a stable state. By not applying systems thinking to the problem of weight loss, people leave the aforementioned negative feedback loop completely out of their mental models, and as a result they often apply the wrong solutions to their problem.

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[82] Hamid, *Thinking in Circles about Obesity*, 33.

[83] Arkalgud Ramaprasad, "On the Definition of Feedback," *Behavioral Science* 28, no. 1 (1983): 9.

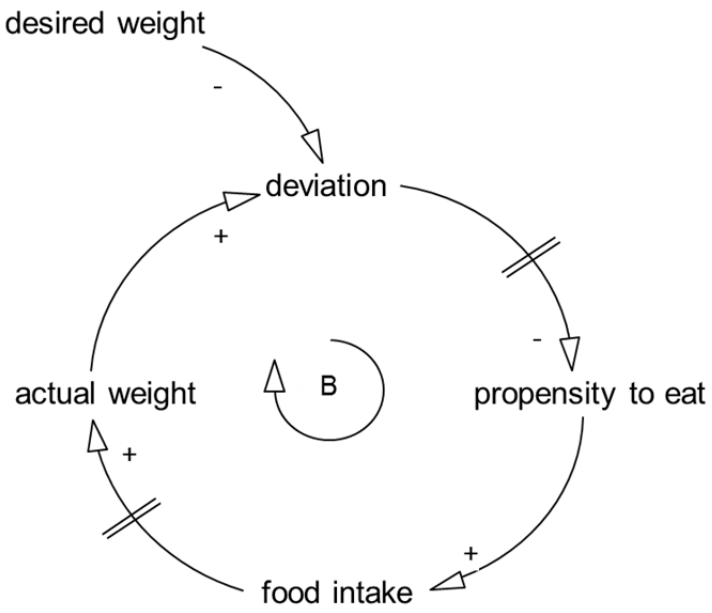

Figure 4. Dieting Feedback Loop[84] (From Sengupta, 2012)

2. The Importance of Feedback

The notion of feedback influences the total systems thinking practice. Feedback is essentially information about a system's past actions that influences present and future behavior. Abdel-Hamid states that feedback encompasses "many of our conscious and subconscious decisions and underlies all goal-oriented behavior."[85] This means that when individuals try to obtain goals, the feedback from their previous actions will ultimately drive their future decisions. In our weight-loss example, the feedback originated from both outside and internal sources. The individual likely used some type of weight-scale to determine the deviation from his/her desired weight, and the body also provided internal feedback in the form of hunger. Together, this feedback directly

[84] In Casual Loop Diagrams (CLDs), a negative sign denotes that the first variable causes a change in the opposite direction in the second variable, and a positive sign denotes that the first variable causes a change in the same direction in the second variable (Rushing, n.d.). The parallel bars indicate a delay between cause and effect. Considering this, by utilizing a systems thinking lens, we can see how improper dieting creates self-stabilizing behavior. Once a dieter observes an unwanted deviation from a desired weight, he/she will subsequently try to moderate their propensity to eat. However, this act actually triggers the body's internal energy conservation measures, and ultimately leads to a higher caloric intake and a stabilization of the dieter's original weight.

[85] Hamid, *Thinking in Circles about Obesity*, 32.

impacted the individual's future eating decisions. Whether the goal consists of losing weight, or more implicitly maintaining an internal energy balance, feedback will provide information on the gap that exists between reality and the overall aim of the system. A goal-seeking system that operates without this information will not effectively meet its goals because it will never possess a way of knowing its overall deviation from the target goal. Hayes-Roth states "all intelligent entities operating in dynamic environments have to adapt their behavior continuously in response to feedback."[86] To illustrate this concept, he puts forth the Adaptive Decision Loop, which demonstrates how intelligent entities constantly need to adjust their behavior to measured feedback in order to get closer to their goals (Figure 5).

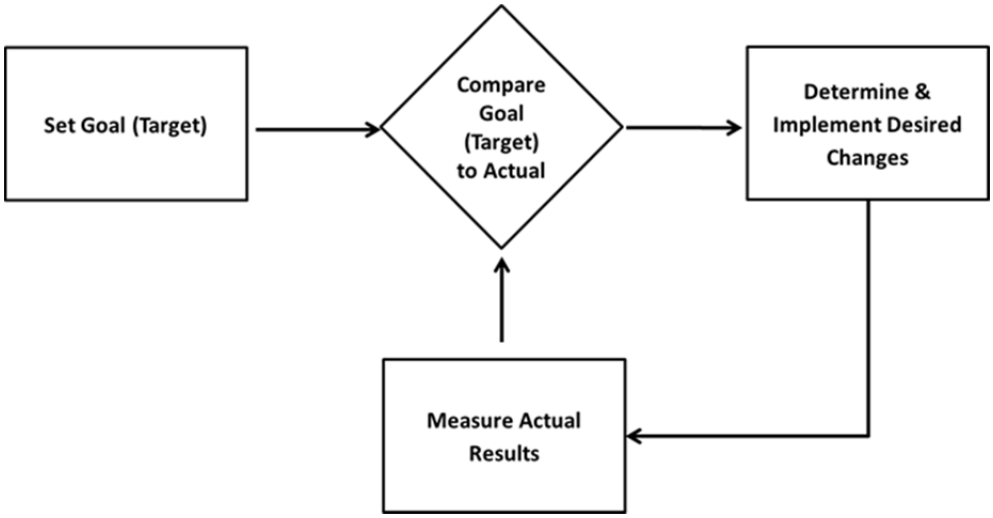

Figure 5. The Adaptive Decision Loop (From Hayes-Roth, 2006)

As seen in this diagram, without proper feedback (measured actual results), the system never knows whether its courses of action actually improve or hurt the goal. Therefore, an understanding of how feedback does or does not work within a system helps us to solve complex problems for a couple of reasons. First, many complex systems intrinsically have feedback loops built into them. In *Thinking in Systems*, Donella H. Meadows states "if you see a behavior that persists over time, there is likely a

[86] Hayes-Roth, *Hyper-Beings*, 64.

mechanism creating consistent behavior. That mechanism operates through a feedback loop."[87] Thus, if one can categorize a problem as a consistent behavior (i.e., sending superfluous e-mails), people will usually discover some form of feedback loop at work within the system. Second, by understanding how feedback works within a system, individuals can then learn how to influence different variables to produce their desired outcomes. Considering this, next we will look at feedback loops more closely to understand the important role they play within systems, and also demonstrate that by leveraging feedback loops we can more effectively manage complex systems.[88]

C. FEEDBACK LOOPS

Feedback loops are powerful engines built into a majority of the systems that we deal with on a daily basis. Feedback loops "self-generate" behavior, making them extremely powerful sources of change.[89] Once a feedback loop initiates, it perpetually keeps itself going until some outside force makes it stop. Therefore, feedback loops have significant implications for any organization whose problem might involve enhancing, controlling, or changing human behavior. In a June 2011 *Wired Magazine* article titled "Harnessing the Power of Feedback Loops," Thomas Goetz gives the example of a dynamic speed display that alerts drivers of their speeding.[90] Cities all over the world employ this relatively simple device to control the excessive speeding of drivers in areas such as neighborhoods, construction sites and school zones. The device works by providing drivers with feedback about their driving behavior, giving them an opportunity to correct their behavior, encouraging better driving habits in the future, and ultimately reducing drivers' speed an average of ten percent.[91] This type of feedback loop succeeds at influencing human behavior because it provides valuable feedback as well as a norm or goal to strive for. In "Self-Regulation through Goal Setting," Gary Latham and Edwin

[87] Meadows, *Thinking in Systems*, 25.

[88] Hamid, *Thinking in Circles about Obesity*, 32.

[89] Richmond, *An Introduction to Systems Thinking*, 59.

[90] Thomas Goetz, "Harnessing the Power of Feedback Loops," *Wired*, June 19, 2011, http://www.wired.com/magazine/2011/06/ff_feedbackloop/, 1.

[91] Goetz, "Harnessing the Power of Feedback Loops."

Locke "determined that goal setting is not very effective without feedback; concluding that goals supported by feedback are more effective in motivating high performance or performance improvement than either one is separately."[92] Therefore, with an appropriate feedback loop in place, individuals can obtain measured feedback about their performance; have an opportunity to compare this feedback to a desired goal; and, have an opportunity to regulate their actions for continuous improvement.

Many organizations have utilized the power of feedback loops to improve internal quality and behavior. Facing the problem of creating poor quality products that did not meet their customers' expectations, many enterprises changed their business models and adopted a management philosophy known as Total Quality Management (TQM). TQM fully embraces the use of feedback loops for performance measurement and behavioral change within an enterprise. Sashkin and Kiser maintain that TQM fundamentally consists of "counting, customers and culture." TQM focuses on changing the culture of an organization to support the "constant attainment of customer satisfaction through an integrated system of tools, techniques, and training."[93] Central to this management philosophy is the notion of customer-defined quality, which means giving the customer, instead of the manufacturer, the ability to define quality expectations.[94] However, to fully understand a customer's expectation of quality, the practice of TQM requires some form of feedback to support an enterprise's continuous improvement of their product or service. The rationale behind feedback and continuous improvement is that a product will never be 100% perfect; however, by using performance measurement tools and gradual improvements an enterprise can get significantly closer to customer-satisfaction without plateauing.[95]

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[92] Todd Cooper, "The Power of Feedback Loops: Attaining and Sustaining a Healthy ERM Program," *Wolters Kluwer Financial Services*, 2011, http://www.riskheadquarters.com/wp-content/uploads/2011_FeedbackLoops.pdf.

[93] Marshall Sashkin and Kenneth J Kiser, *Putting Total Quality Management to Work: What TQM Means, How to Use It & How to Sustain It Over the Long Run* (San Francisco: Berrett-Koehler Publishers, Inc., 1993), 39.

[94] R. Dan Reid and Nada R Sanders, *Operations Management* (Hoboken: John Wiley & Sons, Inc., 2007), 142.

[95] Reid and Sanders, *Operations Management*, 148.

Therefore, feedback loops form the backbone for performance measurement and quality improvement within a TQM organization. A simple feedback loop utilized by many enterprises is the Plan-Do-Check-Act (PDCA) cycle, also called the Shewhart cycle (Figure 6). A manager will develop a plan, carry out the plan, check to see if the plan works correctly, and then subsequently act to improve the plan.[96] This cycle would then continuously repeat, thus constantly improving the manager's future plans. If at all possible, these cycles would then get applied throughout the different levels of the enterprise and to all of its internal processes. Throughout the world, decision makers and workforces utilize this sort of feedback loop to improve their quality of service and to change corporate behavior for the better.

Figure 6. Plan-Do-Check-Act (PDCA) cycle (After Johnson, 2002)

D. BALANCING FEEDBACK LOOPS

Fundamentally, the practice of systems thinking utilizes two different types of feedback loops to better understand system models. Reinforcing feedback loops occur in systems that have the ability to constantly reproduce or have fractional growth.[97] People often refer to these loops as snowball effects. Senge gives the example of a gas-crisis to illustrate how a reinforcing feedback loop works.[98] Once news breaks of a possible

[96] Sashkin and Kiser, *Putting Total Quality Management to Work*, 44.

[97] Meadows, *Thinking in Systems*, 31.

[98] Senge, *The Fifth Discipline*, 81.

gasoline shortage, people will begin rushing to the pumps to fill up their cars. Long lines will form, and subsequently people will start panicking and hoarding as much gasoline as they can get their hands on. This cycle would then perpetuate and eventually snowball out of control. On the other hand, balancing feedback loops contain self-sustaining cycles. The stabilizing, goal-seeking, and regulating properties of these loops work to keep their stock within a given range.[99] In systems thinking, stocks include anything within a system that can potentially accumulate or dissolve.[100] For instance, one could find a balancing feedback loop at work within a person's checking account. The person's money inside the account represents the stock, and the deposits, withdrawals and interest represent the system flows. A conscious consumer would use tools such as bank statements (feedback) to monitor the inflows and outflows, and then make the necessary changes to maintain an ideal cash balance.[101] This type of feedback loop prevents overspending, while also controlling excessive saving. Ultimately, by understanding how balancing feedback loops such as these operate, we can start to address the problem of e-mail overload effectively.

1. Stabilizing

One of the main characteristics of a balancing feedback loop includes its capacity to provide stabilization. For instance, one can think of the cruise control feature in a car. When a driver sets the vehicle's cruise control, an internal computer takes control of the throttle and subsequently maintains the desired speed by automatically adjusting to the feedback provided by the car's onboard sensors. Cruise control provides stability to the driving experience by imposing restrictions on how much the car can surpass or trail the driver's desired speed. Without such stabilization, cruise control would neither make sense nor serve a useful purpose. The human body also depends upon stabilization to work properly. Our bodies utilize balancing feedback loops to stabilize our internal temperature at around 98.6 degrees Fahrenheit, and to ensure that we stay hydrated and

[99] Meadows, *Thinking in Systems*, 28.

[100] Jamshid Gharajedaghi, *Systems Thinking, Third Edition: Managing Chaos and Complexity* (Burlington: Elsevier, 2011), 119.

[101] Meadows, *Thinking in Systems*, 25.

properly fed. However, considering the important role that stabilization plays in most systems, surprisingly many organizations do not account for it when trying to employ performance improvement initiatives. The managers of these enterprises possess the potential for using feedback to self-correct and stabilize their errant systems, yet many times they simply do not realize this potential.[102]

Let us consider e-mail quality improvement efforts from this perspective. Some managers may argue that organizations simply need to eliminate all superfluous information to increase their productivity and the value of their information. However, e-mail requires a balance in order to operate as an effective system. Just as too much superfluous information could destroy the effectiveness of e-mail, an excessively high quality threshold could also do the same. For example, from the receiver's standpoint having an e-mail inbox completely void of inconsequential flotsam would greatly reduce the negative symptoms of information overload. From the sender's standpoint, constantly trying to adhere to a zero-glut policy would transform e-mail into a burdensome technology.

Therefore, instead of trying to eliminate the dissemination of superfluous information completely, managers should aim to control e-mail glut by bringing the disproportionate amounts of superfluous information into an acceptable, stabilized range. This range would ultimately depend on the tolerance, goals and mission of the organization. Depending on the mission some enterprises may require higher information quality thresholds than others. For instance, an expeditionary military base, such as Camp Dwyer in Afghanistan, would likely tolerate considerably less superfluous e-mail than a Personnel Support Detachment (PSD) operating in Norfolk, Virginia. The different missions and threats faced by these two organizations ultimately necessitate different quality thresholds. While too little information filtering at Camp Dwyer could threaten the mission and lives, too much information filtering at a PSD could make e-mail too tedious for day-to-day interoffice communication. However, unlike the cruise

[102] David Nadler, Michael L Tushman, and Nina G Hatvan, *Managing Organizations: Readings and Cases* (Boston: Little, Brown and Company, 1982), 37.

control feature on a car, e-mail currently does not provide users with a method for imposing these different types of quality restrictions.

E-mail quality improvement initiatives, such as e-mail charters, personal e-mail management techniques and filters, work to reduce the level of superfluous information within an organization. Yet, the mental models supporting these initiatives do not provide a way to conceptualize what a stable level of information quality looks like or how the system would work to achieve stability. An organization may set a goal of reducing superfluous information by fifty percent, and subsequently employ one of the aforementioned initiatives; however, they do so without an understanding of the actual level of information quality, and they also have no way to measure the rise and fall of this level. As a result, these initiatives provide organizations with no real way to stabilize the quality of their e-mails.

2. Goal Seeking

As described before, when an enterprise pursues performance-improvement initiatives managers typically set a goal and the enterprise members will hopefully take the necessary steps to reach that goal. However, without measured feedback, many goals go unmet because the individuals have nothing with which to evaluate and compare their performance. Conversely, if an enterprise gives feedback without associated goals the feedback likely gets misinterpreted, misapplied or purely disregarded. This implies that goals without feedback will routinely fail to provide ideal results, and feedback without goals will also routinely fail to provide ideal results. For example, imagine if an organization just instructed its members to tighten their belts and cut costs. While cost-cutting constitutes a goal, it creates a very nebulous one at best. Furthermore, without feedback, employees would have no method to gauge their performance. As a result, some employees would make minuscule cuts, while others would make dangerously severe cuts. Alternatively, an intelligent organization would set goals (*e.g.*, reduce costs by 15%), and then provide measured feedback on the organization's cost-cutting efforts. By doing this, the organization would create a balancing feedback loop that seeks to close

the gap between their present reality and future goals. Goals are important to systems because they explain the function of the system and can also serve as leverage points.[103] However, as Tom Landry, head football coach for the Dallas Cowboys, once stated, "Setting a goal is not the main thing. It is deciding how you will go about achieving it and staying with that plan."

As in the case of the cost-cutting organization, enterprises concerned with reducing superfluous e-mails express nebulous goals such as "cut down on the amount of cc's" and "prioritize your e-mails," but they do not provide measured feedback on their users' actual performance. As a result, performance fails to seek the enterprise's goal effectively. For instance, one can envision a passive missile guidance system that uses infrared sensing to acquire and ultimately hit its target. If the missile's seeker-head stops receiving feedback in the form of infrared radiation from the target, it will never accurately meet its objective. The goal-seeking feature of the missile system depends on feedback. Similarly, in order to improve overall e-mail quality, organizations must clearly define their target and provide the necessary feedback to allow their members to adjust performance as necessary to meet the goal. This means changing how we think about e-mail quality improvement. It means understanding that e-mail quality improvement models intrinsically have goal-seeking behaviors that depend upon feedback to operate properly.

3. Regulating

Systems that contain balancing feedback loops also self-regulate behavior. Over a period of time, a system will automatically prevent performance variables from falling too far above or below their set goal values (Figure 7). A prime example of a self-regulating system appears in Adam Smith's classic theory of the Invisible Hand. Adam Smith's free-market manifesto, *The Wealth of Nations*, describes how market prices will always respond to the balance between supply and demand.[104] Smith states that, "The

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[103] Meadows, *Thinking in Systems*, 161.

[104] John D. Sterman, *Business Dynamics: Systems Thinking and Modeling for a Complex World* (New York: McGraw Hill, 2000), 169.

market price of every particular commodity is regulated by the proportion between the quantity which is brought to market, and the demand of those who are willing to pay the natural price of the commodity."[105] In essence, Adam Smith was referring to a balancing feedback loop. The gap created by supply and demand essentially drives market behavior to self-regulate the price of commodities.

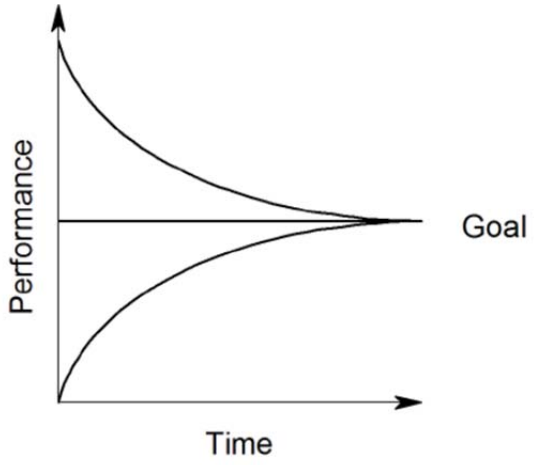

Figure 7. Balancing Feedback Loop (From Kirkwood, 1998)

Likewise, the system models used for e-mail quality improvement initiatives should seek stabilization through regulation. Without regulation, these models fall into a common system trap known as *The Tragedy of the Commons*.[106] This tragedy occurs when individuals who have no incentive to change their behavior overuse a commonly shared, non-renewable resource. Their self-interest brings unwanted results for the entire system. In an article for the journal *Science* in 1968, the ecologist Garrett Hardin first described this dilemma and gave an example of a pasture being shared by multiple herdsmen. Each herdsman would want to maximize the amount of cattle on the pasture in order to maximize his profit. If a herdsman added one additional cow he would create a positive utility of +1, and since all of the herdsmen would share the effects of

[105] Adam Smith, *Wealth of Nations* (Amherst: Prometheus Books, 1991), 59.

[106] Meadows, *Thinking in Systems*, 116.

overgrazing the negative utility would only be fractional.[107] However, as every herdsman tried to maximize his own gain, eventually the commons would wither away. This same type of tragedy occurs with e-mail because it also lacks regulation. With e-mail, data providers ultimately pay a substantially low transaction cost in terms of both money and effort to send superfluous information.[108] As a result, a commonly shared resource gets abused by individuals who face little to no penalty for their actions. However, instead of a pasture, the over-consumed resource in this system consists of the limited processing power in each of our heads and the limited available minutes we have per day to process information. Donella Meadows states the "the tragedy of the commons arises from missing feedback from the resource to the growth of the users of that resource."[109] Therefore, in order to regulate the amount of superfluous e-mail sent from within an organization, organizations must close the feedback connection between actual e-mail quality and desired e-mail quality.

E. CLOSING E-MAIL'S BROKEN FEEDBACK LOOP

The previous explanation of balancing feedback loops demonstrates that organizations should think about e-mail quality improvement initiatives as goal-seeking systems, and not static, linear solutions (Figure 8). Furthermore, in light of this discussion, one can see that most popular e-mail quality solutions fail to incorporate appropriate feedback mechanisms. As Figure 8 illustrates, to close the loop an avenue must exist that allows e-mail users to report on the rise or fall of quality. Without closing this feedback loop, the system will lack stability, operate without regulation, and never reach its intended goal. Therefore, a goal-seeking system needs the capability to transmit information about the outcome of its process back to its source.[110] In order to close e-mail's feedback loop, we ultimately must answer a simple question—How are we doing?

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[107] Garrett Hardin, "The Tragedy of the Commons," *Science*, December 13, 1968, http://www.sciencemag.org/content/162/3859/1243.full.

[108] Shenk, *Data Smog: Surviving the Information Glut*, 187.

[109] Meadows, *Thinking in Systems*, 117.

[110] Hamid, *Thinking in Circles about Obesity*, 32.

By creating and employing a feedback mechanism, we can answer this question and start to control the system intelligently. The system can begin to rely on the feedback mechanism to help close the quality gap by adjusting each subsequent cycle's regulating function to approach an optimal system state.[111]

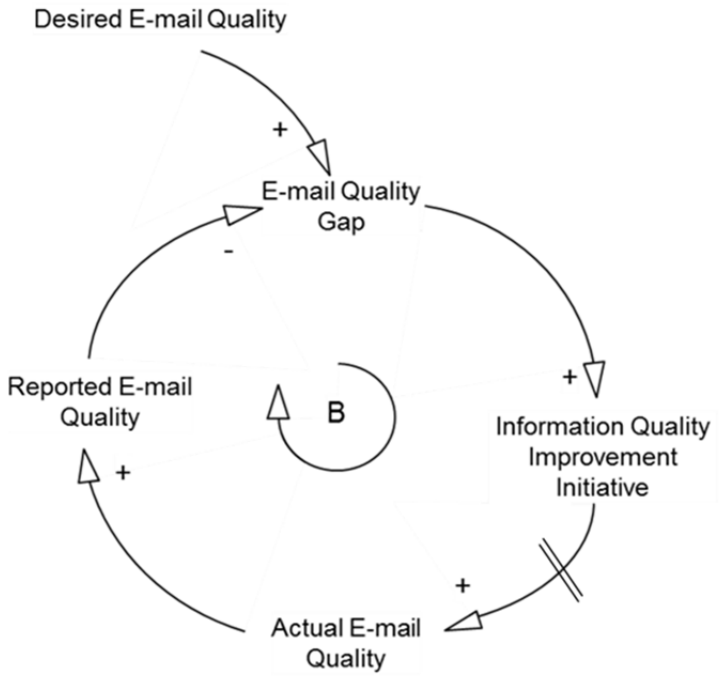

Figure 8. E-mail Quality Feedback Loop[112]

The desired feedback mechanism requires a metric that can effectively appraise the value of an e-mail. Peter Drucker, the influential writer and management consultant, once stated, "If you can't measure it, you can't manage it."[113] Likewise, our inability to measure the amount of superfluous information in our inboxes also means that we are

[111] Hayes-Roth, *Hyper-Beings*, 74.

[112] By including a method to report actual e-mail quality, one gains the capacity to close the feedback loop and create a self-stabilized system. When an unwanted gap forms between desired quality and actual quality, an organization can now intelligently increase their respective quality improvement initiatives. This in turn should increase actual e-mail quality within the organization, leading to an increase in positive quality reporting, and ultimately reducing the gap to an acceptable and balanced figure.

[113] Joyce Hesselberth, "Enabling Analysis," *Synygy Magazine*, 2008, http://www.esresearch.com/e/downloads/EnablingAnalysis_Synygy_Summer08.pdf.

unable to manage appropriately the amount of superfluous information in our inboxes. How can an organization properly measure an entity as intangible as e-mail quality? As the old adage goes, true value rests in the eye of the beholder. Certain members of an organization may find a department-wide e-mail both relevant and useful; however, other members may regard the same message as completely useless. In other words, when it comes to e-mail, the recipient of information ultimately takes on the role of the arbiter of quality. This implies that in order for an enterprise to measure superfluous e-mail, it must take into account subjective valuations. Therefore, much like the principles of Total Quality Management (TQM) and Valued Information at the Right Time (VIRT), this research proposes a feedback metric based on the notion of consumer-defined quality. By using consumer-driven feedback, enterprises can effectively collect and process information about each e-mail user's past behavior as experienced by other e-mail users.[114] The metric that this research proposes is referred to as the Information Glut Ratio (IGR), and Chapter IV will discuss it in greater detail. However, before diving into the inner workings of the IGR, we must first begin to understand the importance of using a quantifiable performance indicator in feedback mechanisms.

1. The Power of Measurements

Measurements constitute the feedback that influences and drives the majority of activities in our daily lives: time, finances, shopping, weather, food, education, health, politics and a myriad of others.[115] These metrics create performance management tools that when correctly utilized can make positive changes in both our personal lives and in the enterprises that we work for. Organizations use metrics every day to help visualize where they are, to identify areas of improvement, and to monitor the important processes which help produce their desired levels of quality.[116] In his book *Transforming*

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[114] Andreas Schlosser, Marco Voss, and Lars Bruckner, *"Comparing and Evaluating Metrics for Reputation Systems by Simulation," Proceedings of the IEEE Workshop on Reputation in Agent Societies, Darmstadt: Darmstadt University of Technology, 2004,* 1.

[115] Dean R. Spitzer, *Transforming Performance Measurement: Rethinking the Way We Measure and Drive Organizational Success* (New York: AMACOM, 2007), 10.

[116] Marvin T. Howell, *Actionable Performance Measurement: A Key to Success* (Milwaukee: American Society for Quality, 2005), 18.

*Performance Measuremen*t, Dean Spitzer states that measurements are incredibly powerful because they make available the "capacity to instigate informed action—to provide the opportunity for people to engage in the right behavior at the right time."[117] Therefore, metrics can quantitatively guide intelligent actions and help to inform us as when we steer off course from our objectives. However, without a way to collect and quantify the system values that we deem most important, the likelihood of our success becomes highly unlikely. One could look at maritime history for proof of this. In October 1707, one of the greatest maritime disasters occurred when Admiral Clowdisley Shovell lost an entire fleet of Great Britain's finest ships. Due to a positional miscalculation, the ships under Shovell's command tragically smashed into the rocks off the Isles of Scilly resulting in the loss of over two thousand lives. It was later discovered that what caused this tragedy was not poor seamanship or inexperience, but rather the navigator's inability to measure longitude properly.[118] Without this ability to measure longitude, every great naval captain in the Age of Exploration, from Vasco de Gama to Ferdinand Magellan, experienced the misfortune of being lost at sea during some point of his career.[119] While mariners fully acknowledged the importance of longitude at this time in history, a chronometer capable of measuring longitude sufficiently did not get invented until much later in the eighteenth century. Although most enterprises today do not overly concern themselves with being lost at sea, they do fall into the same trap as Admiral Shovell and the other maritime captains of this era. They go through their daily activities unable to measure sufficiently the critically important things that help to drive their overall success.[120] In the case of e-mail, many organizational leaders recognize the importance of information quality; however, they continue operating without any form of performance metric.

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[117] Spitzer, *Transforming Performance Measurement*, 11.

[118] Paul R. Niven, *Balanced Scorecard: Step-by-Step for Government and Nonprofit Agencies* (Hoboken: John Wiley & Sons, Inc., 2008), 4.

[119] Dava Sobel, *Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time* (New York: Walker & Company, 1995), 6.

[120] Niven, *Balanced Scorecard*, 4.

2. Actionable Performance Metrics

Performance metrics and system goals form the inputs that drive most goal-seeking systems. When combined, these two entities create the catalysts for change. Goals outline the purpose of the system, and metrics provide the feedback required to stabilize and regulate the system. However, quantifiable metrics will only provide individuals with numerical data. In order to inspire action, the metrics must also provide relevance and consequences.[121] Therefore, when measuring a property like e-mail quality, a metric should contain the following attributes:[122]

- *Simple and Understandable*: The metric must not require a high degree of learnability to begin utilizing it. Ideally, a good metric will allow e-mail recipients to effortlessly measure the value of their e-mails and will allow e-mail senders to effortlessly comprehend the reported feedback returned to them.
- *Meaningful*: The metric must send the right message. When a sender receives feedback about the value of their previously sent e-mails, it must provide enough significance that it drives appropriate action.
- *Timely*: The amount of latency a metric exhibits will affect future behavior. If the e-mail user does not receive the metric in an opportune time, the likelihood of that individual closing the gap between their behavior and enterprise goals will significantly decrease.
- *Well-defined*: The metric must possess distinguishable features and boundaries. By clearly defining the metric, users will garner a better sense of how their behavior affects the metric, and enterprises will create an awareness of the consequences associated with the rise or fall of superfluous e-mail.
- *Cost-effective*: In this era of budgetary belt-tightening, keeping costs down will and should remain a top priority for any proposed technology promising better metrics. However, individuals should also not spend too much time or energy employing a metric. Superfluous e-mails create problems by wasting and interrupting recipients' value-adding time. Considering this, any metric aimed at reducing superfluous e-mail should not indirectly amplify the original problem.
- *Customer-oriented*: As stated before, when it comes to e-mail, the recipient of information is the ultimate arbiter of quality. Therefore, any metric that tries to capture a recipient's subjective valuation of an e-mail must enable a user's unique perception to be gathered, analyzed and later acted upon.

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[121] Goetz, "Harnessing the Power of Feedback Loops."

[122] Howell, *Actionable Performance Measurement*, 5.

F. SUMMARY

A systems-thinking approach to problem solving encourages us to examine how the whole system operates before simply applying unilateral solutions to perceived causations. It allows us to see the interconnections and feedback that drive the system, and ultimately helps to change our mental models. With respect to e-mail improvement initiatives, many enterprises have correctly identified the problems associated with excessive amounts of superfluous interoffice e-mail; however, their models for improvement never account for the consumer feedback required to make their goal-seeking systems operate correctly. As a result, e-mail senders continue to disseminate inconsequential flotsam without any concern of being monitored or regulated. Therefore, in order to close this balancing feedback loop, we must establish a performance metric capable of adequately measuring a consumer's perception of superfluous e-mail. Once employed, this metric will provide a foundation for continuous improvement. Considering this, the following chapter will propose a sensitive, concise and actionable metric that can effectively quantify the amount of superfluous information each user distributes via email over any given time period.

IV. INFORMATION GLUT RATIO

A. MEASURING SUPERFLUOUS E-MAIL

In *Data Smog,* David Shenk likens information overload to the signal-to-noise (SNR) ratio used to measure the strength and effectiveness of a communication signal—how much of the information is actually useful in comparison to how much of it is simply getting in the way.[123] When engineers refer to the SNR they typically mean the power of a communications signal in relation to the power of its accompanying background noise. Communication engineers modify different system variables and then utilize the SNR measurement to determine if their noise reduction efforts improve or diminish the overall signal strength.

$$SNR = \frac{P_{Signal}}{P_{Noise}}$$

E-mail and radio-signals share several similarities in the sense that they both serve as mediums to transfer information and excessive noise can dilute and interfere with the transfer of their information. With a radio signal, a higher noise level signifies an increase in some type of internal electronic sound or an external occurrence such as wind or electromagnetic interference. With respect to e-mail, a higher noise level signifies an increase in the amount of superfluous e-mail received by the recipient. This shared relationship that exists between *noise* and the ability to receive and process information suggests that we can also create a metric similar to the SNR to quantify the amount of superfluous e-mail (noise) being distributed. By taking the inverse of the SNR equation and applying it to problem of e-mail glut, we can create a measurable ratio of the amount of superfluous data bits (U) in relation to the amount of significant data bits (S) that reaches an intended recipient. Superfluous data bits would denote unnecessary, insignificant, inaccurate and/or untimely information, while significant data bits would denote valuable, accurate, and timely information.

[123] Shenk, *Data Smog: Surviving the Information Glut,* 30.

$$\frac{U}{S} = \frac{\#\ Superfluous\ Data\ Bits}{\#\ Significant\ Data\ Bits}$$

This new measurement could provide us with enough quantifiable data to calculate the e-mail quality gap currently unmeasured by most enterprises. However, we must still create a method for adequately assessing the subjective valuation of the data bits received.

1. Capturing an E-mail Recipient's Feedback

To capture and quantify an e-mail recipient's feedback, a person could painstakingly tally up the number of superfluous or significant e-mails received on a daily basis, but this would clearly waste valuable resources and create great user frustration. Instead, this research recommends a simple method of rating information as either superfluous or significant by employing an explicit feedback mechanism embedded into each e-mail message. This recommended feedback device would allow recipients to rate the quality of an e-mail by using a two-state voting mechanism (i.e., thumbs up/down style rating). In this case, a thumbs-up rating would mark a message significant, while a thumbs-down rating would mark a message superfluous. For instance, Pandora Radio, an online music station and recommendation system, uses a two-state voting mechanism to allow its listeners to rate the music they do or do not like (Figure 9). Based on these positive or negative ratings, Pandora Radio continuously tailors their radio stations to more accurately reflect their listeners' preferences. The system records and reacts to customer feedback, yet it does not inconvenience the user with the burden of learning and comprehending a complex rating system. Pandora Radio's simple rating system effectively closes the loop on a goal-seeking feedback loop that aims to provide its listeners with quality, personalized music selections.

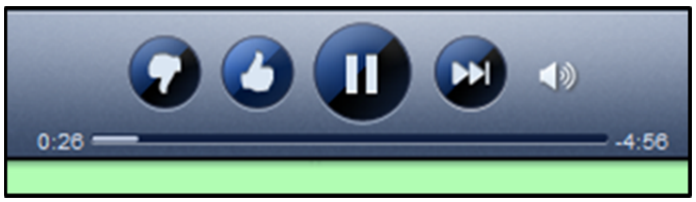

Figure 9. Pandora Radio's two-state voting mechanism (From Pandora Media, 2012)

However, why utilize only a two-state input? Alternative voting mechanisms such as star ratings or letter grading can potentially capture a wider degree of content valuation, while a two-state voting mechanism only captures polarized opinions. For instance, a more expressive voting mechanism could capture the multiple facets of an e-mail's information quality such as relevance, accuracy and timeliness and also the degree to which the content satisfies those attributes. *Wikipedia*, the open-content Internet encyclopedia, uses a comparable rating mechanism to engage their readers in the assessment of article quality (Figure 10).

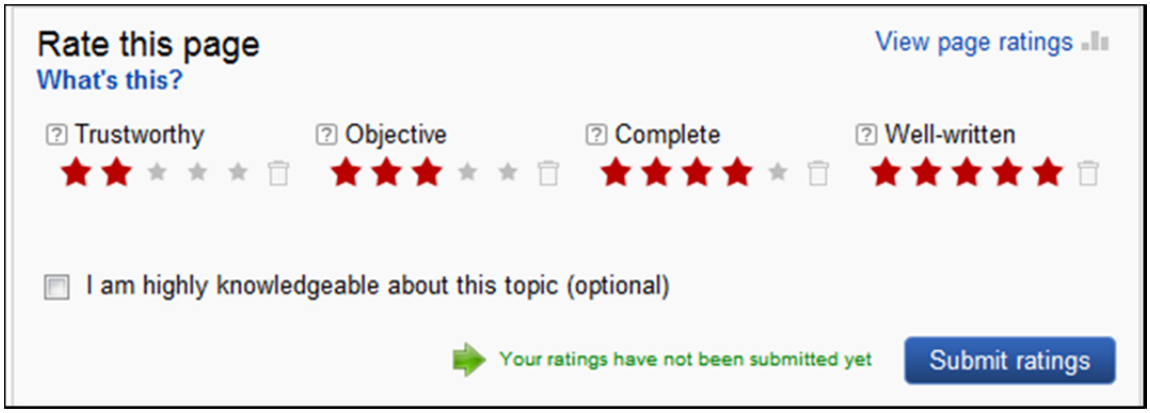

Figure 10. *Wikipedia*'s multi-state voting mechanism (From *Wikipedia*, 2012)

Nevertheless, while these voting mechanisms provide more granular quality assessments, they also have some inherent drawbacks. For starters, voting mechanisms such as star ratings or letter grading ultimately require more contemplation, engagement and time commitment from the user. With respect to e-mail, the average recipient will typically not have the time or motivation needed to thoughtfully analyze and grade the content attributes of every e-mail he or she receives during the course of a day.

Consequently, many users will likely bypass the act of rating content altogether. Another common drawback of multi-state voting mechanisms includes their propensity for rating bias. Most people simply do not find value in rating mediocre things, and as a result the average aggregate scores will routinely create what are known as J-curves or U-curves.[124] This means that the vast majority of the feedback provided by users will normally fall into either the 1-star category or the 5-star category. Therefore, multi-state feedback mechanisms not only have a tendency of reducing explicit inputs due to their complex nature, they also tend to provide the same results as two-state voting mechanisms.

Ultimately, the fly in the ointment for multiple-state voting mechanisms remains the added burden passed onto the raters. I believe that the feedback mechanism used to help control superfluous e-mails should not add negative side effects. Therefore, we should not consider employing a rating mechanism if it creates additional interruptions and absorbs too much time. Two-state voting mechanisms are unambiguous, quick, and require very little effort to use. By employing a thumbs-up/thumbs-down style rating, e-mail recipients will only need to answer a very simple question, "Is the content of this e-mail significant or superfluous to me?"

2. Calculating the Information Glut Ratio (IGR)

Now that we can visualize a practical method for collecting an e-mail recipient's subjective input, the next step involves the employment of these inputs. The proposed method for creating our previously stated measurable ratio would work roughly as follows. Once a recipient rates an e-mail as either significant or superfluous, a rating aggregator would collect the feedback and convert the rating into what this research refers to as an Information Glut Ratio (IGR) for each sender. So for a theoretical e-mail sender (Sender A), we would calculate his IGR at time T by dividing the total amount of superfluous data bits by the total amount of significant data bits. For sender A, the IGR would need to account for all the messages he/she has sent to every person. Therefore, the equation would ultimately need to sum over all recipients. We can refer to this group

[124] F. Randall Farmer and Bryce Glass, *Building Web Reputation Systems* (Sebastopol: O'Reilly Media, 2010), 61.

as R(A), and represent the members of this group as r_1, r_2….r_n (where n equals the total number of recipients in R(A)). The messages rated superfluous from sender A to recipient r_i can be represented by the symbol MA_i, enumerated as mA_{i1}, mA_{i2},…$mA_{i||MAi||}$. If each message mA_{ij} had a size of sA_{ij}, we could subsequently add these corresponding values to calculate the total amount of bits rated superfluous from sender A to recipient i, and denote this sum as UA_i. Similarly, the sum of bits rated significant from A to recipient i we would denote as SA_i. If there were no rated messages, the corresponding value for U or S would be zero. Moreover, in the special case where the denominator sums to zero (*i.e.*, the sender sent no significant messages), the denominator would get replaced by a one to ensure a defined value. Then, by using these values, the IGR (for Sender A) would equal the sum of UA_i (for all recipients i) divided by the sum of SA_i (for all recipients i).

$$IGR(Sender\ A)_T = \frac{UA_1 + UA_2 + ...UA_i + ...UA_n}{SA_1 + SA_2 + ...SA_i + ...SA_n}$$

This process will create a sensitive and concise metric that could effectively quantify the amount of superfluous information that an e-mail user sends over any specified period of time. Let us consider an example. If, over an eight-hour period, an individual sent a total of 395 KB of data recipients rated insignificant, but also sent a total of 850 KB of data rated significant by recipients, the IGR for that user would be 0.46. However, if those figures were reversed, and the user was actually sending more insignificant data bits than significant data bits, their IGR would be 2.15. Therefore, while a large number typically denotes a good SNR, a good IGR would be a figure approaching zero. With the availability of this measurement, an enterprise will now have the capability to: (1) Set measurable goals using this metric; (2) Employ information quality improvement initiatives to meet these measurable goals; (3) Measure the amount of superfluous e-mail in its organization; and (4) Help close the IGR gap (Figure 11). Furthermore, this measurement can develop a powerful e-mail reputation system capable of regulating abuse, developing trust, and motivating quality e-mail contributions. Some may argue that a measure like this may foster risk aversion, encouraging minimum effort for the maximum benefit. However, in reality, completely avoiding e-mail usage in an

office environment would ultimately create far more work rather than reducing effort. These individuals would voluntarily take a giant leap backwards in technology, and only rely on telephone, fax, and face-to-face communication to conduct their business. Considering this, the more likely scenario involves the continuing use of e-mail by these individuals, except now they will try to send e-mails more thoughtfully. The rest of this chapter will demonstrate how the IGR metric provides the feedback needed to make our current e-mail quality improvement initiatives work. Additionally, scenarios will demonstrate how the IGR metric should work to reduce e-mail glut within the DoD.

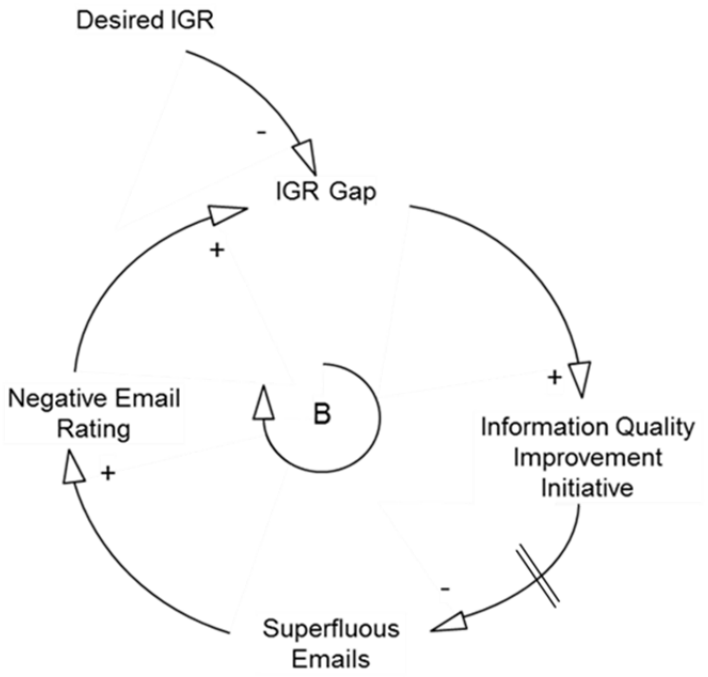

Figure 11. IGR Balancing Feedback Loop[125]

B. IGR: THE MISSING LINK

One of the central arguments presented in this research maintains that without measured feedback our current "solutions" to the e-mail overload problem do not work.

[125] With an IGR metric, an enterprise can now set organizational goals based on IGR scores. If an organization notices a significant IGR gap, resulting from an increase in the amount of negative e-mail ratings, they can subsequently increase or redirect their quality improvement initiatives to more effectively reduce the amount of superfluous e-mails. Once the IGR gap has been closed, and the system stabilized, the organization could then adeptly throttle their preferred regulation.

However, by using a metric like the IGR to provide this missing feedback link, we can close the loop and finally provide these systems with both the regulation and stabilization needed to make them effective.

1. Applying IGR to an E-mail Policy/Charter Initiative

By applying an IGR feedback mechanism, organizations can close the missing connection between their enterprise e-mail policies and their users' behavior. By doing this, organizations can pinpoint the habitual rule breakers, and subsequently provide incentives for them to change. Furthermore, since the IGR does not dictate input requirements, an organization can tailor the IGR feedback mechanism to best suit its enterprise goals. For instance, imagine that an organization decided to adopt Colonel Marksteiner's recommended e-mail policy from Chapter II. Employees would receive the appropriate training on the organization's respective policy and the IGR feedback mechanism. However, instead of instructing their employees to rate e-mails only on the merits of personal significance, the enterprise management could also instruct its users to rate messages on the merits of policy conformity as well (Figure 12). Therefore, if an e-mail recipient received an e-mail that broke policy (i.e., an e-mail "tasker" without an appropriate label and deadline); he or she would subsequently rate the e-mail content negatively with a thumbs-down.

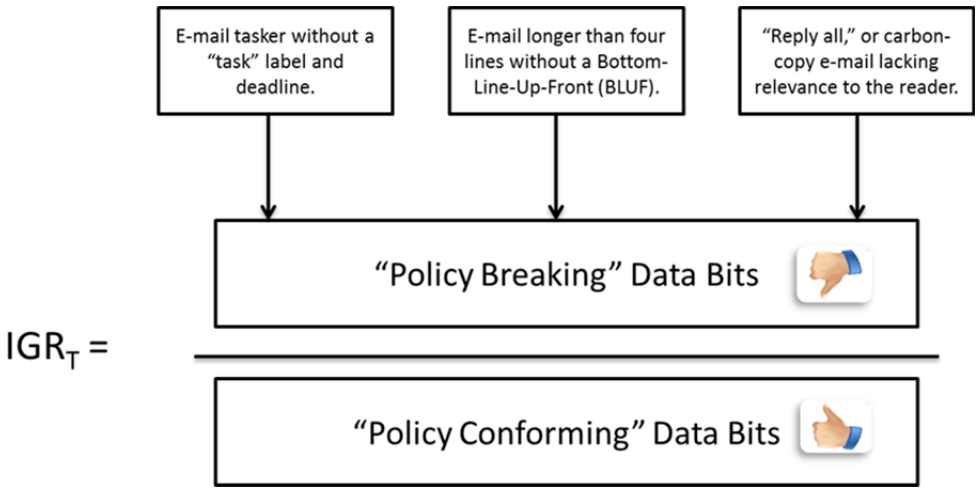
E-mail tasker without a "task" label and deadline.
E-mail longer than four lines without a Bottom-Line-Up-Front (BLUF).
"Reply all," or carbon-copy e-mail lacking relevance to the reader.
IGR$_T$ =
"Policy Breaking" Data Bits
"Policy Conforming" Data Bits

Figure 12. Tailored IGR for E-mail Policy

When assessed in aggregate, this tailored IGR score will effectively provide a tool for finding and regulating policy abusers. Enterprises can moderate abuse, reward value, and ensure that the amount of superfluous e-mails being distributed within their organizations remains within an acceptable range. The final decision on whether to make the regulations remunerative or coercive will ultimately belong to the organization.

Nevertheless, one may still question the incentive for rating e-mails in the first place. I believe that social facilitation and competition will drive a user's behavior in the context of enterprise e-mail glut. The theory of social facilitation maintains that people will tend to perform better merely due to the presence of other individuals.[126] In this case, the simple awareness that other e-mail recipients will potentially evaluate and rate one's e-mail content will incentivize individuals to begin rating the messages that they receive as well. Eventually, this form of social facilitation will create a type of environment where cooperative, healthy competition will drive performance improvement and policy conformity. Additionally, people will have an incentive to rate e-mail for the same reason that the listeners of Pandora Radio rate their music selections. This means that individuals who continuously provide feedback will eventually reap the benefits of a product designed to more suitably meet their needs.

2. Applying IGR to Personal E-mail Management

By employing an IGR feedback loop, e-mail users now gain the ability to influence the quality of e-mails they receive. This does not imply that the IGR will negate the benefits of maintaining an orderly inbox. Instead, the IGR feedback system will complement inbox management by allowing users to share the overall responsibility of reducing information glut with the senders of e-mail. By posting each user's aggregated IGR score on their respective e-mails, an enterprise will create a reputation system that supports the collaborative sanctioning and praising of each sender's e-mail quality.[127]

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[126] Robert B. Zajonc, "Social Facilitation," *Science* 149, no. 3681 (1965): 269.

[127] Audon Jøsang, "Trust and reputation systems," *Foundations of Security Analysis and Design IV, FOSAD 2006/2007 Tutorial Lectures*, (Brisbane, 2007), 222.

Reputation systems are the underlying mechanisms behind such things as Amazon's product reviews and Xbox Live's Achievements.[128] With reputation systems, individuals develop reputations within their respective groups based on peer feedback. How others rate the quality of their content will either favorably or adversely affect the user's reputation. For example, the consumer-to-consumer auction company eBay utilizes a reputation system with its detailed seller ratings (DSR). Sellers get rated based on their selling performance, receive feedback in the form of stars (5 stars being the highest and 1 star being the lowest), face the consequence of being regarded as a bad seller, and then have the opportunity to increase their rating by improving the quality of their next transaction. Therefore, by using reputations, enterprises can measure user feedback and subsequently create value by identifying and incentivizing those individuals who create the best user-generated content.[129] Reputation systems can also serve to educate users. Many times the users of a system will not know that they produce poor quality content because of broken feedback links. They assume that their content has intrinsic value to the people receiving it because they do not receive any complaints. This problem arises quite frequently with respect to e-mail users. Many users do not even realize that they have unconsciously internalized undesirable e-mail habits. They simply do not recognize that they are sending mass quantities of superfluous information. However, with a reputation system, users will learn just how much their recipients truly value their content.

By using an IGR reputation system, e-mail senders can receive measured feedback on the amount of superfluous information that they distribute over a given period of time, compare their results to enterprise goals, and, if necessary, make the proper adjustments to improve the quality of their e-mails (Figure 13). At the same time, e-mail recipients will have the ability to provide necessary feedback about the quality of information received, and more effectively sort, prioritize and organize their e-mails based off a sender's reputation. Quality e-mail contributions would increase a sender's

[128] Farmer and Glass, *Building Web Reputation Systems,* 18.

[129] Farmer and Glass, *Building Web Reputation Systems,* 17.

overall rating, which would beget greater e-mail prioritization within a receiver's inbox, which would then encourage e-mail senders to improve their reputation.[130] In Online Web Reputation Systems, this technique is often referred to as "vote to promote," and will be described further in a later scenario.[131] The IGR reputation system would urge e-mail senders to better understand their recipients' data needs, and to make more mindful decisions about who should receive what e-mails before they push the send button. Ultimately, an IGR reputation system offers a powerful way for individuals to actually control the content of information in their inboxes by encouraging others to adopt better sending habits. More thoughtful information sharing will reduce the burden of personal e-mail management and allow users to process information more efficiently.

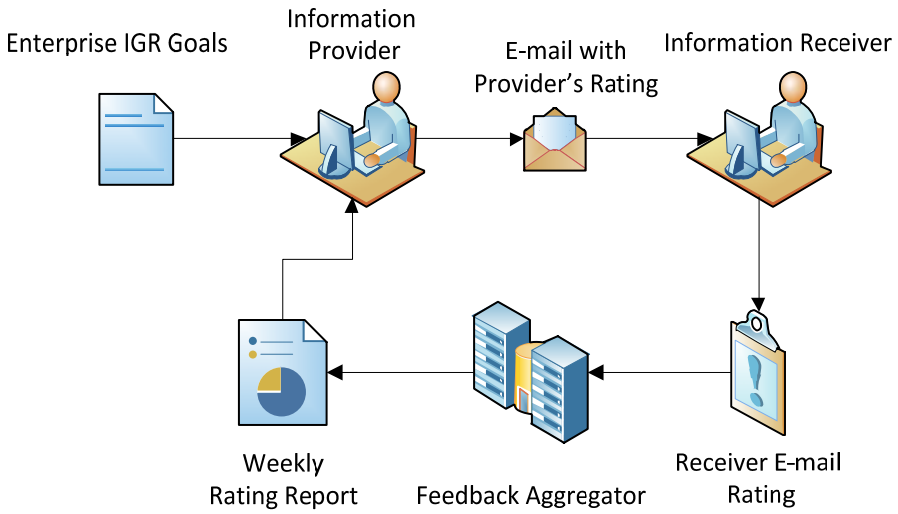

Figure 13. IGR Reputation System

3. Applying IGR to E-mail Filters

Today, certain e-mail service providers (ESPs) provide organizations with the capability to collect user feedback in order to better filter their e-mail recipients. In Request-for-Comments (RFC) 6449, J.D. Falk describes how senders of bulk, transactional, social, or other types of email can use Complaint Feedback Loops (FBLs)

[130] Farmer and Glass, *Building Web Reputation Systems*, 17.

[131] Farmer and Glass, *Building Web Reputation Systems*, 141.

to adjust their mailing practices by "using Spam Complaints as an indicator of whether the recipient wishes to continue receiving email." [132] For instance, before FBLs, an individual who no longer wanted to subscribe to *Organization-A's* weekly newsletter could simply mark the e-mail as spam. Lacking consumer feedback, *Organization-A* would continue to send the individual their newsletter every week—completely unaware that their e-mails were actually being quarantined by the mailbox provider's spam filter. Over time, if more subscribers also marked their newsletters as spam, *Organization-A* could eventually reach the mailbox provider's spam threshold and potentially become blacklisted. However, with FBLs, opted-in organizations receive notification via an Abuse Reporting Format (ARF) message that a subscriber no longer wants to receive their e-mails. With this information, the organization can take appropriate action and quickly remove a subscriber's e-mail address from their distribution-list, thus creating "a happier set of Message Recipients and… fewer Spam Complaints" (Figure 14).[133]

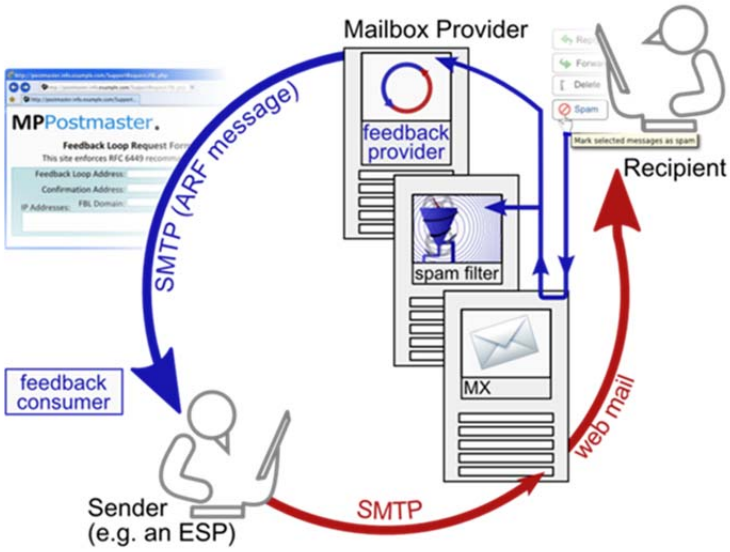

Figure 14. The Complaint Feedback Loop (From Vesely, 2011)

[132] J. Falk, "Request for Comments: 6449," *Internet Engineering Task Force (IETF)*, November 2011, http://tools.ietf.org/html/rfc6449.

[133] Falk, *Request for Comments: 6449.*

The Complaint Feedback Loop effectively notifies senders about which and how many recipients value their information, and it subsequently encourages e-mail senders to change their behavior. Changed behavior could mean simply deleting a recipient, or it could also mean refining "mailing frequency, list management, message content, and other measures."[134] Like the practice of Total Quality Management, this feedback measure allows the recipient to define quality, and encourages the sender to filter recipients and content as necessary. However, an FBL in its current form only creates a one-time loop. Once a sender receives a recipient's feedback, they will never again interact with that individual through e-mail. Therefore, this solution clearly does not provide a practical solution for handling superfluous interoffice e-mail.

Alternatively, an IGR feedback mechanism similarly encourages effective content and recipient filtering, but unlike the FBL it provides an unbroken feedback loop capable of supporting continuous improvement. Based on a user's feedback, an e-mail sender will essentially develop into an active self-filtering system that constantly refines the quality of e-mail content in order to meet their recipient's information needs. The IGR score urges e-mail senders to acknowledge their recipients' opinions and encourages them to ask quality improvement questions prior to sending each e-mail: [135]

- What do recipients do with my e-mail after they receive it?
- What are the problems that my e-mail recipients have?
- What more can I do to help them solve those problems?

This process eventually leads to incremental improvement over time. IGR feedback causes users to reflect on the quality of their sent e-mail, reduce or eliminate substandard behaviors (i.e., excessive carbon-copying), and in essence evolve the quality of their e-mail content. This belief is roughly based on Albert Bandura's social learning theory. To change behavior, people must go through a process of learning. Bandura states that "most human behavior is learned observationally through modeling: from observing others one forms an idea of how new behaviors are performed, and on later

[134] Falk, *Request for Comments: 6449.*

[135] Michael Hammer, *The Agenda: What Every Business Must Do to Dominate the Decade* (New York: Crown Business, 2001), 140.

occasions this information serves as a guide for action."[136] Therefore, by embedding a cumulative IGR score into every user's e-mail, an individual has opportunities to observe how highly rated e-mail users draft and target their e-mails. Latham and Locke state, "Peers can influence goal commitment by conveying normative information, by persuasion, and by serving as role models."[137] Therefore, with an IGR rating system, individuals will go through a continuous process of learning their recipient's needs, filtering their output, and modeling their behavior after the highest scoring senders.

C. IGR SCENARIOS

The following hypothetical scenarios will help illustrate how an enterprise such as the Department of Defense could employ the Information Glut Ratio.

1. IGR Routine Scenario

While reviewing departmental training reports, the Operations Officer (OPS) onboard a guided-missile destroyer (DDG) notices that an e-mail flagged as important has arrived in her inbox. After stopping her work to read the e-mail, she notices that the subject line states "*Important New Guidance*," and that the entire wardroom received the message. The e-mail originated from the ship's Combat Systems Officer (CSO) and the message's body included information about an upcoming seasonal uniform shift. However, to the OPS, this e-mail provided neither timely nor important information. The guidance was originally disseminated via shipboard message traffic several weeks ago. Furthermore, during the morning meetings, the Executive Officer had reminded the entire wardroom and chief's mess about the upcoming uniform shift on several occasions. With an IGR rating system in place, the Operations Officer decides to rate the CSO's e-mail as superfluous due to its redundant content.

Following this action, the Operations Officer's e-mail rating gets sent to the ship's rating aggregator in order to calculate the CSO's Information Glut Ratio. The

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[136] Albert Bandura, *Social Learning Theory* (Englewood Cliffs: Prentice-Hall, Inc., 1977), 22.

[137] Gary P. Latham and Edwin A. Locke, "Self-Regulation through Goal Setting," *Organizational Behavior and Human Decision Processes* 50, (1991): 219.

aggregator's software recognizes that the CSO's e-mail received a negative rating and that the size of the original message was 26 KB. As a result, the value of superfluous data bits gets stored in a database for later calculation (Figure 15).

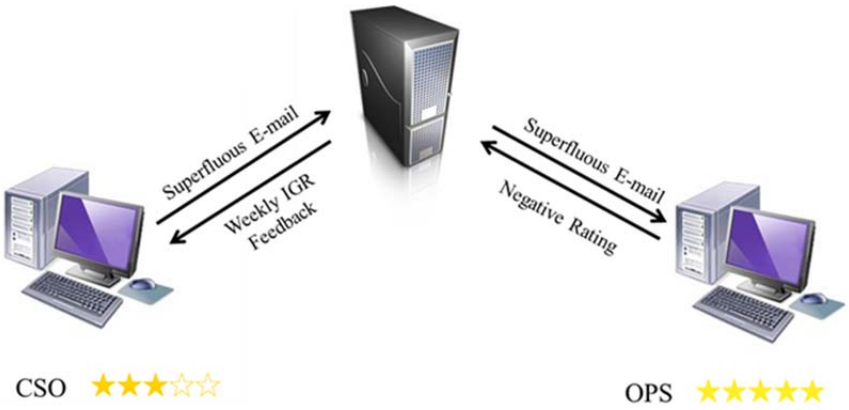

Figure 15. IGR Routine Scenario

Throughout the course of the day, the rating aggregator gets more feedback from the rest of the e-mail recipients concerning the value of the CSO's message. In total, 28 recipients rated the e-mail as superfluous and two recipients rated the e-mail as significant. Subsequently, the value of the superfluous data bits rises to 728 KB (26 KB x 28 negative ratings) and the value of the significant data bits rises to 52 KB (26 KB x 2 positive ratings). At the end of the week, the aggregator software calculates the value of both the significant and superfluous data bits sent by the CSO, and it then calculates his new IGR. As it turns out, over the course of the week the CSO had sent 3640 KB of superfluous information, and 2500 KB of significant information, resulting in a weekly IGR of 1.46. Prior to this week, the CSO's yearly IGR was hovering around .89; however, due to a weeks' worth of superfluous e-mail, his IGR increased to 1.2. His numeric IGR score then goes through a de-normalization process to convert into

a presentable format before updating his personal user profile.[138] In this command, the ship prefers to utilize stars like those in e-Bay to differentiate between great (five stars) and poor (one star) contributors.

Based on the overwhelmingly unfavorable feedback the CSO received concerning his e-mail about the seasonal uniform changes, he decides to cut back on sending office wide e-mail blasts. He also takes the time to reflect on how he can improve the content and targeting of his e-mail in the future.

2. IGR Regulation Scenario

The Commanding Officer (CO) at a Navy Operational Support Center (NOSC) reviewed his command's weekly IGR report and noted that the majority of his staffs' scores steadily improved over the last six month. This corresponded with a noticeable decrease in the size of his e-mail inbox, fewer e-mail interruptions, as well as an overall increase in the quality of information disseminated. However, the CO also noticed an incongruity in the IGR report. The NOSC Supply Officer's IGR score had shown relatively marginal improvement and was almost triple the size of the other staff members. After looking through his e-mail trash folder, the CO quickly realized why the Supply Officer's IGR score remained so high. The last three e-mails sent from the Supply Officer contained large attachments (roughly 500 KB) and contained mostly irrelevant information.

The CO's previous plan for rewarding value based on each individual's IGR score proved successful. Known as "vote to promote," staff members who maintained IGR scores between (0 and 1.0) were provided a higher precedence and their e-mails received a more prominent placement within their recipients' inboxes.[139] The CO even began a process of weighting his top performers. Individuals who maintained an IGR score below a 1.0 threshold were granted additional rating power. Each time a top performer rated an e-mail, his or her feedback would get multiplied by a Performance Coefficient

[138] Farmer and Glass, *Building Web Reputation Systems,* 180.

[139] Farmer and Glass, *Building Web Reputation Systems,* 68.

(PC) to yield a weighted score. The rationale behind this was that individuals who took e-mail quality improvement seriously would receive an incentive to continue this behavior, and weighted ratings would also empower top performers to better regulate the system.

On the whole, the majority of the NOSC staff had fully embraced the IGR system and the CO's rating incentives. However, the Supply Officer never fully adopted the rating system, and basically viewed the entire process as a complete waste of time. For that reason, he continued along with the improper practice of sending insignificant emails, misusing carbon-copy features, and saturating his colleagues' inboxes with over-sized e-mail attachments. Considering this, the CO ultimately decided to impose more restrictive IGR regulations in order to bring the Supply Officer's nonconforming behavior into balance with the system's goals.

Within the NOSC, e-mail inbox quotas have traditionally been utilized to regulate the amount of server space that each e-mail user consumes (Figure 16). Anytime a person reached an inbox quota of 200 MB, he or she would not be able to send any additional e-mails. These limits effectively helped to control the size of the NOSC e-mail database, and it also encouraged better inbox management.

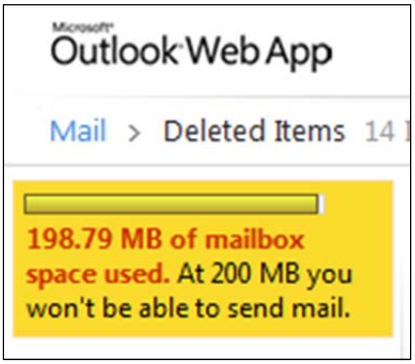

Figure 16. Sample E-mail Inbox Quota (From Microsoft Corporation, 2012)

Employing a comparable style of regulation, the CO decided to restrict those individuals regarded as habitual e-mail "glutters" within the command. Before the implementation of an IGR rating system, the NOSC simply did not have the capacity to

measure information glut. Consequently, management fundamentally lacked an actionable performance metric to initiate any form of informed regulation. However, by utilizing IGR scores, the CO could now develop a two-phase regulation system to help control the e-mail outboxes of poor performers. The first-phase regulation activated once a user crossed a 4.0 rating threshold. At this point, the configured SMTP server would reject any e-mails larger than 80 KB originating from *poor performers*. The second-phase regulation would activate once a member crossed a 5.0 rating threshold. At this point, the configured SMTP server would completely restrict the *poor performer* from sending e-mail. Furthermore, this individual would need to complete e-mail policy/etiquette training. As soon as the user completed training, their IGR score would reset to 4.0 and the user would once again have an opportunity to improve his or her performance and score.

Following the implementation of this new regulation, the overall cost for sending sloppy, superfluous messages became too high for the Supply Officer to keep ignoring. After a few missteps, he eventually started to self-regulate the quality of his e-mails, and ultimately lowered his IGR score to a more manageable number.

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V. CONCLUSION AND RECOMMENDED FURTHER RESEARCH

A. CONCLUSION

> In the long run, excesses of technology mean that the comparative advantage shifts from those with information glut to those with ordered knowledge, from those who can process vast amounts of throughput to those who can explain what is worth knowing and why.[140] —*Hugh Heclo*.

Ultimately, the only effective way to deter information overload from occurring on any communication medium comes from restricting the transmission of data to only the significant, actionable bits. Any time that superfluous information flows without some form of regulation, the data receivers will experience reduced productivity, increased interruptions, slower decision making, and higher levels of unnecessary stress. In essence, insignificant data will glut receivers to the point of failure. Organizations have a clear choice. They can continue to spend large sums of money on increasing processing power, storage and bandwidth speed to accommodate the exponential rise in available data. Or they can develop effective strategies for reducing the amount of insignificant data currently deluging their receivers. With regard to e-mail, many organizations have attempted to employ different quality improvement initiatives to regulate and hopefully bring order to the free flow of data within their enterprises; however, the mental models behind these initiatives are generally flawed since they only offer static, linear solutions. By looking at the problem of e-mail overload through a systems-thinking lens, this research demonstrates that both the problem and solution consist of a more circular and balancing nature. To this extent, this study has shown that the behavior-modifying strategies required to moderate the dissemination of superfluous e-mail are goal-seeking systems that rely on feedback loops to reach their aims.

As Goetz noted in his *Wired Magazine* article, a feedback loop involves four distinct stages: evidence, relevance, consequence and action. First, a method for measuring an individual's performance must exist. In this case, the measured

[140] Shenk, *Data Smog: Surviving the Information Glut,* 199.

performance consists of the amount of superfluous information one sends over e-mail. Second, the measured performance needs to get relayed to the individual in a "context that makes it emotionally resonant."[141] This means that the feedback needs to be presented in a meaningful manner that contextually demonstrates whether their behavior is in line with the stated goal. Third, the individual must have one or more paths to correct his or her behavior; and lastly, the individual needs to take action.

Taking this into consideration, this research proposes an Information Glut Ratio (IGR) to measure each e-mail user's performance and provide the necessary consumer feedback both to encourage individual action and to support enterprise regulation. With a system like this in place, e-mail users now have the capacity to compare their performance to their organization's goals and subsequently embark on a continual quality improvement process to ensure that their future e-mail content consists of more significant information than superfluous information. The IGR metric and its associated rating system also allows organizations to ensure that one of their most valuable resources, human processing capacity, does not get abused by individuals who have no incentive to change their behavior.

The military has regulated communication channels for decades to ensure that only valuable information. For instance, onboard Navy ships, HF and UHF communication channels are used to pass valuable, timely information between vessels. The information passed over these channels typically remains glut-free primarily because the organization has built a balancing feedback loop into the system. Anytime a radio operator begins to pass too much superfluous information, another operator will quickly inform him or her to stop cluttering the channel. This simple form of feedback safeguards radio channels from user abuse. As a result, watch officers and tactical operators eventually begin to take pride in delivering only the information worthy of broadcast. In essence, the operators continuously self-filter their data to improve the overall situational awareness and competitive advantage of the collective group. Therefore, the idea of using receiver feedback and performance metrics to provide

[141] Goetz, "Harnessing the Power of Feedback Loops."

balance and regulation to e-mail content should not seem outlandish. However, as with the implementation of any performance metric and/or feedback tool, organizational leadership must embrace the process and take the necessary action to tune the system, engage the users and encourage organizational change. In *Transforming Performance Measurement*, Dean Spitzer acknowledges the importance of this belief when he states, "while measurement alone is a necessary condition for success, it alone is not sufficient for it. We still must take action."[142]

B. RECOMMENDED FURTHER RESEARCH

The following section puts forth three recommendations on how to go deeper and address the limitations of the current research. This section also identifies the benefits and challenges of each of these ideas. By using these recommendations, hopefully others will build upon them and further explore the potential of employing an IGR system.

1. Develop a Testable IGR Prototype

This research provides a design for a theoretical e-mail content feedback system and then employs use-case scenarios to help conceptualize the system's potential for reducing information glut within an enterprise like the DoD. However, further work needs to be done in order to determine whether the IGR system will actually achieve the desired objectives. Therefore, by developing a prototype one could begin to assess the functionality of the proposed design concept and potentially provide an executable set of requirements for future system development.[143]

A recommended prototype would consist of an operational IGR rating/aggregator capable of functioning with a traditional SMTP server. By developing a working prototype, researchers can examine the technical requirements, prospective costs and potential design issues associated with the deployment of an IGR system. It will also provide researchers with an opportunity to bench-test a coded IGR model by using

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[142] Spitzer, *Transforming Performance Measurement*, 11.

[143] Keith F. Snider and Rene G Rendon, *Management of Defense Acquisition Projects* (Reston: American Institute of Aeronautics and Astronautics, 2008), 71.

simulated inputs to assess the overall performance and accuracy of the system.[144] However, by prototyping this idea one may run into some challenges. First, researchers may experience significant time constraints as they try to design and develop the appropriate system software. To help overcome this challenge, researchers should develop appropriate software requirements early in their research, and also establish clear termination criterion in order to complete the necessary testing and evaluation of the prototype. Second, a prototype's functionality can provide misleading indicators of future success and failure. A prototype could properly meet all of a researcher's stated functionality requirements; however, it still may not satisfy the appropriate suitability parameters for the user. Considering this, further research should also evaluate user participation and acceptance of an IGR system.

2. User Acceptance and Participation

As previously stated, another issue not fully addressed in this study is whether users will truly find usefulness in an IGR system, and furthermore show a willingness to take part in a continual process of rating interoffice e-mail content. The current research examines the potential utility of an IGR system, and also proposes different methods to support user acceptance and participation; however, real customer interaction and feedback is ultimately needed to substantiate any claim of performance improvement.

Considering this, further research address the following questions: (a) how would the rating of e-mail content actually impact individual performance? (b) What are the motivations and disincentives for participating in an IGR process? (c) How do potential users perceive the process, especially IGR reputation scores? To answer these questions, researchers could conduct beta-testing by releasing a prototype to a restricted audience. Or, the researchers could conduct controlled user experiments to test the validity of the concepts proposed in this study. Further research could also involve qualitative observations, interviews, or guided surveys. One challenge with this type of research involves the elicitation and recruitment of a quality sample population. Another challenge

[144] Farmer and Glass, *Building Web Reputation Systems*, 228.

involves the high potential for response bias considering the overall novelty of this research topic. To counter these challenges, researchers should use large, random populations to mitigate validity threats, and also replicate their studies to confirm similar results.

3. Conduct a Cost-Benefit Analysis for an IGR System

A future study aimed at calculating the cost-benefit analysis (CBA) of an IGR system would also provide value. Unquestionably, the design, development, and roll out of an IGR system would require a sizable investment. However, the current study does not attempt to quantify either the acquisition costs or the possible benefits involved in such an information technology (IT) investment. Therefore, further research could help establish the efficiency and overall benefit of an IGR system implementation.

Vivek Kundra, the former Chief Information Officer (CIO) of the United States, believes that in comparison to the private industry the U.S. has achieved little in terms of productivity improvements from IT, even though the government has spent roughly $600 billion on IT over the past decade.[145] Unquestionably, this type of spending without proven results will come under scrutiny in this era of increased fiscal constraint. Considering this, what are the costs of an IGR system, and do the proposed productivity benefits outweigh these costs?

[145] Vivek Kundra, "25 Point Implementation Plan to Reform Federal Information Technology Management," *CIO.gov*, December 9, 2010, http://www.cio.gov/documents/25-point-implementation-plan-to-reform-federal%20it.pdf.

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LIST OF REFERENCES

Alberts, David S, John J Garstka, and Frederick P. Stein. *Network Centric Warfare: Developing and Leveraging Information Superiority.* Washington, DC: DoD C4ISR Cooperative Research Program, 2000.

Anderson, Chris. "How to Stop e-Mail Overload? Think Before You Hit Send." *The Washington Post*, September 9, 2011. http://www.washingtonpost.com/opinions/how-to-stop-e-mail-overload-think-before-you-hit-send/2011/09/09/gIQATMBorK_story.html.

Anderson, Christopher, and Jane Wulf. *E-mail Charter.* June 9, 2011. http://emailcharter.org/about.html.

Bandura, Albert. *Social Learning Theory.* Englewood Cliffs: Prentice-Hall, Inc., 1977.

Bessler, Manuel. *Civil-Military Guidelines & Reference for Complex Emergencies.* New York: United Nations Office for the Coordination of Humanitarian Affairs, 2008.

Blair, Ann. "Information Overload, Then and Now." *The Chronicle Review*, November 28, 2010. http://chronicle.com/article/Information-Overload-Then-and/125479/.

Cooper, Christopher, and Robert Block. *Disaster: Hurricane Katrina And the Failure of Homeland Security.* New York: Times Books, 2006.

Cooper, Todd. "The Power of Feedback Loops: Attaining and Sustaining a Healthy ERM Program." *Wolters Kluwer Financial Services*, 2011. http://www.riskheadquarters.com/wp-content/uploads/2011_FeedbackLoops.pdf.

Csíkszentmihályi, Mihály. *Flow: The Psychology of Optimal Experience.* New York: Harper Collins Publishers, 1991.

Denning, Peter J. "Infoglut." *Communications of the ACM* 4, no. 7 (July 2006): 15–19.

Edmunds, Angela, and Anne Morris. "The Problem of Information Overload in Business Organisations: A Review of the Literature." *International Journal of Information Management, Volume 20*, Issue 1 (2000): 17–28.

Falk, J. "Request for Comments: 6449." *Internet Engineering Task Force (IETF).* November 2011. http://tools.ietf.org/html/rfc6449.

Farmer, F. Randall, and Bryce Glass. *Building Web Reputation Systems.* Sebastopol: O'Reilly Media, 2010.

Freeman, John. *The Tyranny of E-mail: The Four-Thousand Year Journey to Your Inbox.* New York: Scribner, 2009.

Gharajedaghi, Jamshid. *Systems Thinking, Third Edition: Managing Chaos and Complexity.* Burlington: Elsevier, 2011.

Goetz, Thomas. "Harnessing the Power of Feedback Loops." *Wired,* June 19, 2011. http://www.wired.com/magazine/2011/06/ff_feedbackloop/.

Gray, Peter O. *Psychology: 5th Edition.* New York: Worth Publishers, 2006.

Hall, Robert J. "How to Avoid Unwanted Email." *Communications of the ACM* 41, no. 3 (March 1998): 88–95.

Hamid, Tarek K.A. *Thinking in Circles About Obesity.* New York: Springer, 2009.

Hammer, Michael. *The Agenda: What Every Business Must Do to Dominate the Decade.* New York: Crown Business, 2001.

Hardin, Garrett. "The Tragedy of the Commons." *Science*, December 13, 1968. http://www.sciencemag.org/content/162/3859/1243.full.

Hayes-Roth, Rick. "Valued Information at the Right Time (VIRT): Why less volume is more value in hastily formed networks." *NPS Cebrowski Institute*. 2006. http://faculty.nps.edu/fahayesr/docs/VIRTforHFNs.pdf

———. *Hyper-Beings: How Intelligent Organizations Attain Supremacy through Information Superiority.* Bangor: Booklocker.com, 2006.

———. "Model-based Communication Networks and VIRT: Filtering Information by Value to Improve Collaborative Decision-Making." Paper presented at the 10th International Command and Control Research and Technology Symposium: The Future of C2, McLean, Virginia, 2005.

———. "Model-based Communication Networks and VIRT: Orders of Magnitude Better for Information Superiority." Paper presented at MILCOM 2006, Washington, DC, 2006.

———. "Two Theories of Process Design for Information Superiority: Smart Pull vs. Smart Push." Paper presented at the 2006 Command and Control Research and Technology Symposium, San Diego, California, 2006.

Hesselberth, Joyce. "Enabling Analysis." *Synygy Magazine,* 2008. http://www.esresearch.com/e/downloads/EnablingAnalysis_Synygy_Summer08.pdf.

Howell, Marvin T. *Actionable Performance Measurement: A Key to Success.* Milwaukee: American Society for Quality, 2005.

Hurst, Mark. *Bit Literacy: Productivity in the Age of Information and E-mail Overload.* New York: Good Experience Press, 2007.

IORG—Information Overload Research Group. n.d. http://iorgforum.org/about-iorg/ (accessed June 20, 2012).

Iqbal, Shamsi T, and Eric Horvitz. "Disruption and Recovery of Computing Tasks: Field Study, Analysis, and Directions." *Proceedings of the SIGCHI conference on Human factors in computing systems (CHI '07).* New York: ACM, 2007. 677–686.

Jackson, Thomas, Ray Dawson, and Darren Wilson. "The Cost of Email Interruption." *Journal of Systems and Information Technology* 5, no. 1 (2001): 81–92.

Johnson, Corinne N. "The Benefits of PDCA." *Quality Progress*. May 2002. http://asq.org/quality-progress/2002/05/problem-solving/the-benefits-of-pdca.html.

Joint Chiefs of Staff. *Joint Publication 3-13: Information Operations*. Washington, DC, February 13, 2006.

Jøsang, Audon. "Trust and Reputation Systems." *Foundations of Security Analysis and Design IV, FOSAD 2006/2007 Tutorial Lectures.* Brisbane, 2007. 209-245.

Jung, Jaeyeon , and Emil Sit. "An Empirical Study of Spam Traffic and the Use of DNS Black Lists." *4th ACM SIGCOMM conference on Internet measurement (IMC '04).* New York: ACM, 2004. 370-375.

Kelly, Walt. *Pogo: We have met the Enemy and He is Us.* New York: Simon and Schuster, 1972.

Kim, Susanna. "Tech Firm Implements Employee 'Zero Email' Policy." *ABC News*, November 29, 2011. http://news.yahoo.com/tech-firm-implements-employee-zero-email-policy-165311050.html.

Kirkwood, Craig W. "System Dynamics Methods: A Quick Introduction." *Arizona State University.* April 1, 1998. http://www.public.asu.edu/~kirkwood/sysdyn/SDIntro/ch-1.pdf.

Klingberg, Torkel. *The Overflowing Brain: Information Overload and the Limits of Working Memory.* New York: Oxford University Press, Inc., 2009.

Kundra, Vivek. "25 Point Implementation Plan to Reform Federal Information Technology Management." *CIO.gov.* December 9, 2010. http://www.cio.gov/documents/25-point-implementation-plan-to-reform-federal%20it.pdf

Latham, Gary P, and Edwin A Locke. “Self-Regulation through Goal Setting.” *Organizational Behavior and Human Decision Processes* 50, (1991): 212–247.

Losey, Stephen. “OPM Mistakenly Tells 300 They are Presidential Management Fellows Finalists.” *Federal Times*, February 10, 2012. http://www.federaltimes.com/article/20120210/PERSONNEL02/202100303/.

Magnuson, Stew. “Military ‘Swimming In Sensors and Drowning in Data.’” *National Defense Magazine*, January 2010. http://www.nationaldefensemagazine.org/archive/2010/January/Pages/Military‘SwimmingInSensorsandDrowninginData’.aspx.

Marksteiner, Peter R. “The Threat from Within: E-mail Overload Degrades Military Decision-making.” *Armed Forces Journal*, September 1, 2008. http://www.armedforcesjournal.com/2008/09/3640424/.

Mayfield, Ross. “E-Mail Hell.” *Forbes*, October 15, 2008. http://www.forbes.com/2008/10/15/cio-email-manage-tech-cio-cx_rm_1015email.html.

Meadows, Donella H. *Thinking in Systems.* White River Junction: Chelsea Green Publishing, 2008.

Microsoft Corporation. “Microsoft Outlook Web App.” *Naval Postgraduate School Outlook Web Access.* n.d. (accessed August 20, 2012).

MIT. “New Measure of Human Brain Processing Speed.” *Technology Review.* August 25, 2009. http://www.technologyreview.com/view/415041/new-measure-of-human-brain-processing-speed/.

Nadler, David, Michael L Tushman, and Nina G Hatvany. *Managing Organizations: Readings and Cases.* Boston: Little, Brown and Company, 1982.

Nguyen , Anh. “Email is 'Counter-Productive' Says Salesforce.Com.’” *CIO*, September 8, 2010. http://www.cio.com/article/610593/Email_is_Counter_Productive_Says_Salesforce.Com.

Niven, Paul R. *Balanced Scorecard: Step-by-Step for Government and Nonprofit Agencies.* Hoboken: John Wiley & Sons, Inc., 2008.

Pandora Media, Inc. *Pandora Internet Radio.* n.d. http://www.pandora.com/ (accessed August 14, 2012).

Radicati, Sara, and Masha Khmartseva. “E-mail Statistics Report, 2009-2013.” *The Radicati Group, Inc.* May 2009. http://www.radicati.com/wp/wp-content/uploads/2009/05/email-stats-report-exec-summary.pdf.

Ramaprasad, Arkalgud. “On the Definition of Feedback.” *Behavioral Science* 28, no. 1, (1983): 4–13.

Rechtin, Eberhardt. *Systems Architecting of Organizations: Why Eagles Can't Swim* . Boca Raton: CRC Press LLC, 2000.

Reid, R. Dan, and Nada R Sanders. *Operations Management.* Hoboken: John Wiley & Sons, Inc., 2007.

Richmond, Barry. *An Introduction to Systems Thinking.* Hanover: High Performance Systems, Inc., 2001.

Richtel, Matt. “Lost in E-Mail, Tech Firms Face Self-Made Beast.” *The New York Times,* June 14, 2008. http://www.nytimes.com/2008/06/14/technology/14email.html?_r=3&pagewanted=1&sq=information%20overload%20research%20group&st=cse&scp=2.

Rushing, William M. “Causal Loop Diagrams: Little Known Analytical Tool.” *iSix Sigma.* n.d. http://www.isixsigma.com/tools-templates/cause-effect/causal-loop-diagrams-little-known-analytical-tool/ (accessed August 15, 2012).

Sashkin, Marshall, and Kenneth J Kiser. *Putting Total Quality Management to Work: What TQM Means, How to Use It & How to Sustain It Over the Long Run.* San Francisco: Berrett-Koehler Publishers, Inc., 1993.

Schlosser, Andreas, Marco Voss, and Lars Bruckner. “Comparing and Evaluating Metrics for Reputation Systems by Simulation.” Proceedings of the IEEE Workshop on Reputation in Agent Societies. Darmstadt: Darmstadt University of Technology, 2004.

Schulman, Miriam. “E-mania: Ethical Approaches to E-mail Overload.” *Santa Clara University: Markkula Center for Applied Ethics.* June 24, 2005. http://www.scu.edu/ethics/publications/submitted/emailoverload.html.

Senge, Peter M. *The Fifth Discipline: The Art & Practice of the Learning Organization.* New York: Doubleday, 1990.

Sengupta, Kishore. *Complexity: How to Leverage Time & Stop its Tyranny*. Presentation at the Naval Postgraduate School, Monterey, California, March 9, 2012.

Shanker, Thom, and Matt Richtel. “In New Military, Data Overload Can Be Deadly.” *The New York Times*, January 16, 2011. http://www.nytimes.com/2011/01/17/technology/17brain.html?_r=2&pagewanted=all.

Shenk, David. *Data Smog: Surviving the Information Glut.* New York: HarperCollins Publishers, 1997.

Smith, Adam. *Wealth of Nations.* Amherst: Prometheus Books, 1991.

Smith, Brenda D. *Breaking Through: College Reading.* London: Longman, 2005.

Snider, Keith F, and Rene G Rendon. *Management of Defense Acquisition Projects.* Reston: American Institute of Aeronautics and Astronautics, 2008.

Sobel, Dava. *Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time.* New York: Walker & Company, 1995.

Spitzer, Dean R. *Transforming Performance Measurement: Rethinking the Way We Measure and Drive Organizational Success.* New York: AMACOM, 2007.

Stanford. "Social Norms." *Stanford Encyclopedia of Philosophy.* March 1, 2011. http://plato.stanford.edu/entries/social-norms/.

Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World.* New York: McGraw Hill, 2000.

Thomas, Gail Fann, and Cynthia L King. "Reconceptualizing E-Mail Overload." *Journal of Business and Technical Communication* 20, (2006): 252–287.

Thomasch, Paul, and Jim Finkle. "New York Times sends email to millions by mistake." *Reuters,* December 29, 2011. http://www.reuters.com/article/2011/12/29/us-newyorktimes-subscribers-idUSTRE7BS0IH20111229.

Van Creveld, Martin L. *Command In War.* Cambridge: Harvard University Press, 1985.

Vesely, Alessandro. "Feedback Loop (email)." *Wikipedia: The Free Encyclopedia*. November 2011. http://en.*Wikipedia*.org/wiki/File:Feedback_loop_(email).png.

Whittaker, Steve, and Candace Sidner. "Email Overload: Exploring Personal Information Management of Email." Proceedings of the ACM Conference on Human Factors in Computing Systems. New York: ACM, 1996. 276-283.

Wikipedia: The Free Encyclopedia. *Wikipedia:Article Feedback Tool.* July 3, 2012. http://en.*Wikipedia*.org/wiki/*Wikipedia*:Article_Feedback_Tool.

Young, H. Peyton. *Social Norms.* Discussion Paper, Oxford: University of Oxford, 2007.

Zajonc, Robert B. "Social Facilitation." *Science* 149, no. 3681 (1965): 269–274.

Zeldes, Nathan, David Sward, and Sigal Louchheim. "Infomania: Why We Can't Afford to Ignore it Any Longer." *First Monday: Peer Reviewed Journal on the Internet.* August 6, 2007. http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/1973/1848

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